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Progress in the Artificial Dehydration of Forage Crops in the United States[1]

By H. B. Josephson[2]

H. B. Josephson

CONSIDERABLE advancement has been made in the dehydration of forage crops in the United States during the past few years. This progress has been made not only through the work of the state and federal agricultural experiment stations but also through the efforts of certain private individuals and companies who have spent their time and money in developing new systems and machines for drying agricultural products.

The discovery that furnace gases made a suitable drying medium and had no harmful effects on the products has possibly been the greatest contribution so far made to the science of forage crop dehydration. It may be called the direct method of dehydration. This method now generally employed in this country, was first conceived and developed by Arthur J. Mason whose process of drying alfalfa will be referred to later. The advantages of the direct over the indirect method of applying heat (as passing air over steam coils) lie in greatly simplifying the drying mechanism and increasing its thermal efficiency. Of more recent origin is the practice of using the undiluted furnace gases at high temperatures. 1000 to 1600 degrees (Fahrenheit). This method promises possibilities of more efficient utilization of fuel and some plants using that principle have operated with a very low power consumption as well. At present we have drying plants of two distinct types, those drying rapidly at high temperatures and those drying slowly at low temperatures, considerable thought has been given recently to portable driers and one company is now manufacturing several oil-burning driers light enough in weight that they may be transported from farm to farm.

It is probably typical of American methods that much of the pioneer work in this new field was done by building actual machines costing several thousands of dollars before much basic information was available on their requirements. A great deal of the experimental work has therefore been done on large machines operating under actual field conditions. This practice, though costly, has probably brought results more rapidly than if more conservative procedure had been followed. A number of the state experiment stations are now conducting tests on machines that have been developed by commercial firms.

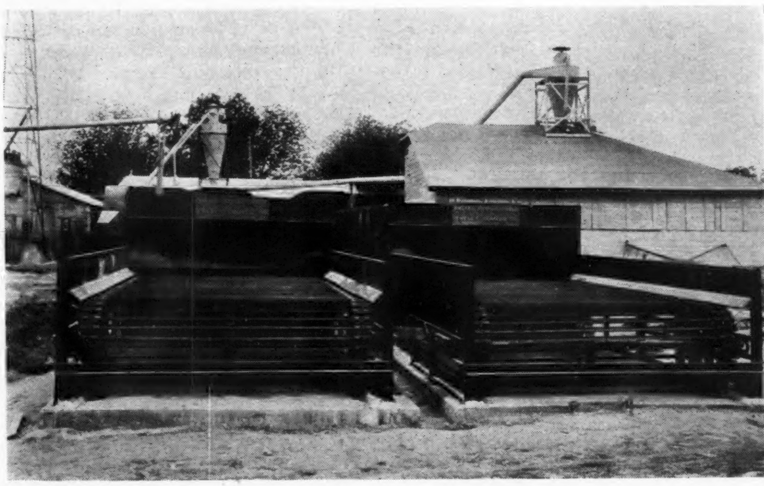
There are now about eighteen hay drying installations in the United States. These are scattered throughout different parts of the country where high rainfall prevails. The state of Louisiana leads with eight driers. With the exception of an experimental drier built by the Louisiana State University these are all commercial machines built by at least eight different concerns. A study of the various driers reveals a wide variation in design and mechanical principles employed.

EARLY WORK OF THE U. S. D. A.

As early as 1909 the U. S. Department of Agriculture began a study of the artificial curing of alfalfa hay. The

[1]Paper presented at the International Congress of Agricultural Engineering, Liege, Belgium, August 1930.

[2]Associate professor of agricultural engineering, Pennsylvania State College. The official representative of the American Society of Agricultural Engineers at the International Congress of Agricultural Engineering. Mem. A.S.A.E.



Loading or wet end of a Bayley forage drier two-tunnel installation. Conveyor type, 150-by-10-foot open or closed tunnels, coal or oil burning, uses 60 gallons of oil per ton of dried hay, and 30 horsepower, not including grinding. Capacity about 1.5 tons dried hay per hour

following is quoted from a report by H. B. McClure[3]:

> "The need of some means for applying artificial heat to the curing of hay has long been urged and was brought definitely to the attention of the Department of Agriculture some years ago by T. P. Russel of Hayti, Mo. Mr. Russel was formerly a lumberman and his experience in the use of drying kilns for curing lumber suggested the feasibility of applying similar means to the curing of hay."

An experimental hay drier was built and operated for three seasons, 1910 to 1912. It was described as follows:

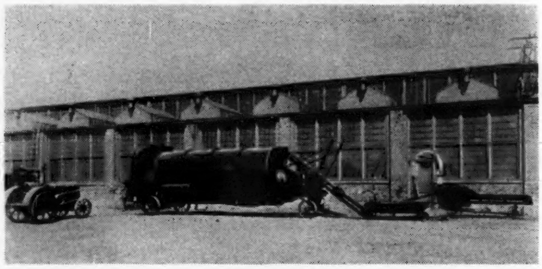
> "As originally designed, the machinery of the hay drying kiln consisted of seven endless conveyors arranged in a building 20 feet high. The hay to be cured is fed into these conveyors by means of an inclined elevator, the lower end of which is at a convenient height for the haymakers that bring the supply from the field. The top conveyor travels from front to rear a distance of 30 feet and there drops the hay to the conveyor immediately below, which travels in the opposite direction. The hay passes back and forth in this manner over the seven conveyors, and is finally delivered to a second shorter discharge elevator which communicates with the storage barn. A system of steam coils installed beneath the conveyors provides the means of maintaining the desired degree of heat."

After three years of development work the machine had a capacity of 653 pounds of cured hay per hour when working with freshly cut alfalfa. It is stated that fuel was by far the largest item of cost. Important conclusions drawn were that artificial curing effected an immense saving in leaves and smaller stems which comprise a large percentage of the best part of the hay product largely lost by field curing; that the process must be confined to large growers or small growers operating on a community basis; and that the drying plant may be able to pay for itself in a single season under favorable conditions. Appropriations for the maintenance of this project were discontinued in 1914. No further work was done along the line by the U. S. Department of Agriculture until about 1928 when a general revival of interest in the subject was manifested in all parts of the country.

RECENT WORK OF THE U. S. D. A.

In an effort to determine some of the fundamental requirements of drying hay, the division of agricultural engineering of the U. S. Department of Agriculture undertook some laboratory work in 1928. Hurst[4] experimented among other things with the use of air at different temperatures. Heated air was passed through a layer of alfalfa hay about 10 inches in thickness. The temperature of the inlet air was varied between 118 and 161 degrees. It was found that as the temperature of the air increased the number of heat units required to evaporate each pound of water decreased. With this experimental dryer a minimum of 4280 B.t.u. were required to evaporate each pound of water when the air entered the drier at 161 degrees. This low efficiency is attributed to losses in the exhaust air. No provision was made for recirculating the air.

The artificially cured alfalfa was in all cases of the best quality with an average protein content of 20.4 per cent. The same hay when field cured under favorable conditions was found to have 1.0 per cent lower protein content. This was attributed to leaf shattering alone. It was concluded that the principle of rapid, controlled drying in no way increases the actual protein content over that of the fresh forage as has sometimes been suggested, but, on the other hand, no protein is lost through waste of leaves, as may occur in varying degrees under field conditions. Discussing the economic considerations of artificial drying, it is shown that due to the uncertainty of securing a good quality of natural cured hay the artificially cured hay might be expected to bring from $6.00 to $7.00 per ton more than the average price for field-cured hay.



Portable Ardrier ready to operate. Rotary-drum type, stationary or portable, coal or oil burning, dries with undiluted furnace gases at about 1500 degrees, uses 200 pounds of coal or 15 gallons of oil per ton of dried product, plus 30 horsepower. Capacity one to two tons of dried product per hour

WORK OF THE EXPERIMENT STATIONS

Experimental work on dehydration of hay has been in progress at the Louisiana Agricultural Experiment Station since 1926. Nadler and Osterberger[5] laid down the requirements of a practical hay drier as follows: (1) High thermal efficiency; (2) low initial cost; (3) simple operation and control; (4) low power consumption; (5) simple design and low maintenance cost; (6) ability to provide hay having high food value, color, aroma and palatability; (7) ability to reduce the moisture content to a predetermined amount low enough for storage; and (8) capacity sufficient to take care of average acreage, and to keep labor, power and overhead charges within economic limits.

After considerable experimentation these men developed a drier of the rotary kiln type that seemed to come reasonably near fulfilling their requirements. As a drying medium the products of combustion from an oil furnace were used with little or no dilution of air. This drier was a radical departure from earlier machines in that temperatures as high as 1600 degrees were used. The high temperature of the entering gases was permissible because of the absence or low content of oxygen. In other driers using a considerable amount of air as admixture with the furnace gases, the temperature at entrance is usually kept below 300 degrees in order to avoid charring and danger of combustion. The drier had a drum 3 feet in diameter and 28 feet in length. At one end of the drum was the furnace and at the opposite end a suction fan. The hay, after being cut into short lengths with an ensilage cutter, was fed into the drier at the furnace end. The interior of the drum was provided with several fins running lengthwise with the cylinder so that as the drum rotated the material was carried to the top of the drum and dropped into the gas stream. The suction fan carried the hay through the drum as well as providing induced draft for the furnace. Under test the drier showed a thermal efficiency as high as 56 per cent based on 1100 B.t.u. necessary to change one pound of water at 80 degrees to steam at 212 degrees.

In 1929 a larger drier of the same principle was built. It has a drum 6 feet in diameter and 40 feet long. As reported by Barr[6] who is now in charge of the Louisiana project, a capacity of 2600 pounds of dried alfalfa per hour with a thermal efficiency as high as 59 per cent has been obtained with the new drier. The total power requirements are 15.5 horsepower distributed as follows: Driving ensilage cutter, 10; rotating the drum, 2.5; driv-

[3]McClure, H. B. "The Artificial Curing of Alfalfa Hay," U. S. Department of Agriculture, Circular No. 116, March 8, 1913.

[4]Hurst, W. M. and Kiesselbach, T. A. "Drying Alfalfa Hay by Forced Draft with Heated Air." AGRICULTURAL ENGINEERING, Vol. 10, No. 7, pp. 218-220, July 1929.

[5]Nadler, C. S. and Osterberger, C. L. "Experiments on the Artificial Curing of Hay," AGRICULTURAL ENGINEERING, Vol. 10, No. 6, pp. 191-193, June, 1929.

[6]Barr, H. T. "Hay Drying Tests in Louisiana." Paper presented at a meeting of the Southern and Southwest Sections of the American Society of Agricultural Engineers, Jackson, Miss., February, 1930.

ing exhaust fan, 2 and driving the dry hay elevator, 1. This is a very low power consumption as compared with many other driers now in operation.

A drier for treating hay or grain in stacks was designed and built at Purdue University in 1926 by William Aitkenhead[7]. The plan followed the one developed at the University of Oxford[8] with the exception that in the Purdue drier the hot gases of combustion were passed through the stack.

Research projects have recently been organized at the Alabama and Pennsylvania agricultural experiment stations. The Alabama station has under observation a drier built by the Louisville Drying Machine Company, of Louisville, Ky., while tests are being made at the Pennsylvania station on a Randolph drier built by the O. W. Randolph Co., of Toledo, Ohio. The latter study will include feeding trials as well as tests on the mechanical operation of the drier. The New Jersey Agricultural Experiment Station has kept records on the operation of the Mason drier used by the Walker-Gordon Laboratory Co., at Plainsboro, N. J., since it was installed in 1926. The results will soon be published. This study includes records on power and labor requirements, capacity and fuel consumption of the plant and chemical analyses on the products.

COMMERCIAL HAY DRIERS

The wide variation in mechanical principles employed in the different driers that have been built by commercial concerns in the United States makes their study of particular interest and value. Considerable ingenuity is displayed in the design of many of these drying plants and great credit is due to the inventors who have fearlessly done pioneer work in this new field.

According to mechanical construction most of the commercial driers may be classified as follows: (1) Conveyor (2) tray or (3) rotary kiln type.

Early Development Work. As early as 1911 Arthur J. Mason, whose work in artificial dehydration of alfalfa has become internationally known, had an experimental drier at West Point, Miss. About three years later he built a drier near Chicago where his experimental work continued for many years, culminating in the development of the present Mason system of drying alfalfa.

A drier for curing alfalfa was built and operated by the Bayley Blower Co., of Milwaukee, Wis., in 1915. This drier was designed and built in response to an inquiry from the McCracken Land Co., of Houston, Tex., and was sold to the Pharr Milling and Elevator Co., at Pharr, Tex.

The Louisville Drying Machinery Co., of Louisville, Ky., began experimenting with a rotary steam-tube drier for drying forage crops about 1915. One of these driers has been in use until recently but the company has discontinued the rotary, steam-tube drier in favor of a direct system of dehydration.

1. CONVEYOR TYPE DRIERS

The Mason Drier[9]. The first hay-drying plant operated on a commercial basis by Arthur J. Mason was located near Flossmoor, Ill. It was operated in 1925 in drying alfalfa. Since then Mr. Mason was built at least four similar drying plants and organized the Mason Alfalfa Process Co., of Philadelphia, Pa.

The Mason drier consists essentially of an endless conveyor belt 9 feet wide, running the entire length of a closed tunnel or drying oven, 150 feet in length. The green alfalfa is first passed between carding rolls whose function is to place a ribbon of the material of uniform thickness upon the conveyor. Heated air and gases from a furnace are forced into the drying tunnel by a blower fan. This drying medium enters at a temperature of 300 degrees and passes through the ribbon of alfalfa. The time required for drying is about 30 minutes. When the dried hay is discharged at the opposite end of the conveyor it is fed into a hammer mill, ground to a meal and blown into the storehouse.

No predrying is allowed in the Mason process of curing hay. Special field machines have been built that first mow the hay, then cut it into lengths of 12 inches or less and finally elevate it into trucks driven alongside. The capacity of one of the Mason plants operated by the company has been found to be two tons of dried hay per hour. The total power consumption of this plant, including the blower-fan and conveying and grinding machinery, is about 120 kilowatts (161 horsepower).

The Bayley Forage Drier. The Bayley Blower Co., of Milwaukee, Wis., has built several driers of the conveyor type. The drier proper consists of a tunnel 150 feet long, 10 feet wide and 7 feet high, through which the endless conveyor belt, built of steel channels mounted on endless chains, travels on rollers on angle iron tracks on the sides of the tunnel. By baffles the heated air and gases from a furnace are made to pass alternately up and down through the hay. Cool air is drawn through the finished hay before it is discharged from the drier, serving to cool the finished hay and conserve a portion of the heat. This air is then raised in temperature by mixing it with the flue gases, the mixture being forced into the drier by a fan at 250 degrees. When the hay has an initial moisture content of 60 per cent it passes through the drier in about 2½ hours, at the rate of 1½ tons per hour. By means of a variable speed mechanism the speed of the conveyor may be changed to suit the condition of the crop being dried. The fuel consumption is about 60 gallons of oil per ton of dried hay. The power requirement of the drier is about 30 horsepower. This does not include grinding as the hay is ordinarily not ground as it leaves the drier.

A two-tunnel drier working on the above principle has recently been installed on the farm of Ward Mooring, near Bryan, Texas. This drier is provided with oil-burning furnaces.

The Bayley Blower Co. has also designed a drier termed a "gas drier." In construction it is similar to the one described above; the essential difference being that the tunnel is completely enclosed and no air is mixed with the combustion gases entering the drier. Insulation is provided by an outer shell completely inclosing the drier which serves as a return duct for the gases being returned to the furnace for reheating.

The Fulmer Drier[10]. Another conveyor-type drier similar to the Mason plant has been built by J. H. Fulmer on his farm near Nazareth, Pa. The tunnel enclosing the conveyor is built of cinder-concrete construction to prevent heat losses as far as possible. Mr. Fulmer uses the common mower, side-delivery rake and hay loader in the field, and the hay is usually allowed to dry in the swath about 2 or 3 hours before loading. This reduces considerably the water that must be evaporated by the drier but does not dry it sufficiently to cause much leaf shattering.

The capacity of the Fulmer drier is about two tons of dried hay per hour with a fuel consumption of 700 pounds of coal per ton of dried hay. The plant uses about 112 horsepower distributed between fan, grinder and other mechanism of the drier.

2. TRAY-TYPE DRIERS

The Louisville Drier. At least two driers of the tray type have been built by the Louisville Drying Machinery Co., of Louisville, Ky. Their drier consists essentially of four rectangular compartments or trays with perforated

[7]Aitkenhead, William. "Some Stack and Grain Drying Results," AGRICULTURAL ENGINEERING, Vol. 8, No. 8, pp. 218-219, August, 1927.

[8]University of Oxford, Institute of Agricultural Engineering. "Preliminary Report of an Investigation into the Artificial Drying of Crops in the Stack," Bul. No. 2, 104 pages. Published by Oxford University Press, Oxford, England.

[9]Kiefer, H. E. "Artificial Drying of Alfalfa and Other Crops," AGRICULTURAL ENGINEERING, Vol. 8, No. 12, pp. 329-333, December, 1927.

[10]Fulmer, J. H. "Development of a Hay Drier and Its Use on an Eastern Farm," AGRICULTURAL ENGINEERING, Vol. 10, No. 2, pp. 68-70, February, 1929.

bottoms, on which the wet alfalfa is placed and dried by a blast of warm air forced upward through the perforations. The capacity is given by the manufacturer at 5 tons in a 12-hour day.

The Randolph Drier. The O. W. Randolph Co., of Toledo, Ohio, has built two tray-type driers, one of which has been placed at the Pennsylvania Agricultural Experiment Station for experimental work. The drier proper consists of a compartment 5 feet wide, 8 feet long and 14 feet in height, open at the top. Trays 12 inches deep with perforated bottoms loaded with green hay are hoisted electrically and lowered into the drier which accommodates six trays. The horizontal dimensions of the trays are such as to fit neatly inside of the drier. Hot gases from a furnace mixed with air are forced into the drier at one end through a manifold which distributes the drying mixture in such a way that it is forced through the hay and out at the opposite end of the drier. The trays are lowered by gravity as the drying progresses and are removed one by one through an opening in one side near the bottom. The temperature of the entering gas mixture is regulated automatically by thermostatic control.

3. ROTARY KILN DRIERS

The Hero Drier[11]. This drier was built by Nuna C. Hero on his father's farm near New Orleans, Louisiana, several years ago. Although the Hero drier is no longer in use it is mentioned here because of certain features which are of interest. It was the first drier to utilize a suction fan for drawing the dried hay from the kiln, which feature has the advantage that the light dry parts of the plants pass through more rapidly than the heavier parts containing more moisture. In the Hero drier the furnace gases were not allowed to come in contact with the hay.

The Ardrier. The first rotary-kiln forage crop drier to be built commercially in this country is the Ardrier designed and built by the Arnold Drier Co., of Galesville, Wis. This is also one of the first commercial driers to use the undiluted combustion gases as a drying medium.

The rotary kiln of the Ardrier consists of three concentric cylinders riveted together and communicating with each other in such a way as to form a continuous channel three times the length of the kiln which is 18 feet in length. A suction fan provides motive power for drawing the forage through all three cylinders in succession. The furnace gases enter the inside or smallest cylinder at a temperature of about 1500 degrees at the end opposite the fan. The green forage, after being passed through an ensilage cutter, enters the drier with the hot gases. As the kiln rotates the particles of green hay are carried around inside the cylinder until they drop by gravity and are made to advance by the moving gases. When the forage reaches the end of the first cylinder it falls by gravity into the second cylinder where it passes in the opposite direction and drops into the third or outside cylinder. After passing through the outside cylinder it enters the fan from where it is discharged to the storehouse. The light leafy material passes through this drier in about 30 seconds while the greener stems may require as much as six minutes.

The Ardrier has a capacity of from one to two tons of dried hay per hour with a power consumption of about 30 horsepower for driving the cutter and fan and rotating the drum. The manufacturer claims a fuel consumption of 200 pounds of coal or 15 gallons of oil per ton of dried product.

Several protable driers of the same capacity as the above machine provided with oil burners are now being built by the Arnold Dryer Co. The first of these will be used by the U. S. Department of Agriculture for experimental work.

The American Process Drier. One of the regular line of rotary driers manufactured by the American Process

A machine for cutting, crushing and spreading alfalfa, to speed up natural drying (made by Food Machinery Corporation, San Jose, California)

Co., of New York, N. Y., has recently been adapted to the drying of forage crops. This drier is installed on the farm of the Walker-Gordon Laboratory Co., at Juliustown, N. J., and has been used for drying alfalfa and corn fodder. During the past winter it was used daily for drying cow manure, and during the summer season it is to be used for drying alfalfa during the day and manure at night. Air is mixed with the hot furnace gases entering this drier before coming in contact with the material to be dried.

OTHER NEW DRIERS

The Koon Drier[12]. A system of forage crop drying whereby the undiluted furnace gases are used as a drying medium has recently been developed by Arthur W Koon, of Schriever, La. Two of these driers have been built and operated on large dairy farms; one on the Brook Hill Farm, Genesee Depot, Wis., the other one on the farm of A. Montz, of La Place, La. The former produced 1100 tons of dried hay during the season of 1929.

In the Koon drier the hay is first cut into short lengths with an ensilage cutter from where it is blown into a cone-shaped collector which serves as a charger for the drier. From the collector the forage is fed into a blower fan which also draws hot gases from the furnace. The gases enter the drier at about 1000 degrees. The material is blown through an insulated pipe in contact with the hot gases and discharged into a second collector, which in turn delivers the material to a second fan together with another charge of hot furnace gases. This process is repeated six times, there being six fans and six collectors. Pipes lead from all but the first collector back to the furnace for recirculation of the drying medium. The last fan delivers the dried material to the storehouse. The hay passes through the drier in about 45 seconds. According to the owners, the capacity of the Koon drier has been found to be from 1 to 1½ tons of dried hay per hour with a fuel consumption of about 400 pounds of coal per ton of dried hay when the hay was allowed to lie in the swath from five to six hours before loading. The power requirement of this drier is about 150 horsepower, including the operation of the ensilage cutter and driving the six fans.

Several other companies are working on new systems of forage crop drying, the details of which, however, are not yet disclosed to the public. One of these, The Agricultural Drier Corp., Columbus, Ohio, will soon offer for sale a portable forage crop drier. A. V. Sims, of the Sims Pump Valve Co., New York, N. Y., is the inventor of a new system for drying hay. The Cushman Engineering Co., Riverside, Calif., has developed a system of treating hay in the field by crushing the stems which is claimed to reduce greatly the time required for field curing. The Herberts Engineering Co., Memphis, Tenn., is developing

[11] Waggoner, J. E. "The Hero Hay Drier," "The Country Gentleman," Vol. 92, No. 11, p. 44. November, 1927.

[12] "Cures Hay in Wet Weather," "The American Thresherman," Vol. 32, No. 5, September, 1929.

a process for drying forage crops through the use of chemically dehydrated air.

FIELD MACHINERY

The Mason Alfalfa Process Co. has developed special harvesting machines for mowing the forage and loading it on trucks in one operation. By this method the crop is harvested and dried with the minimum of labor, there is no loss of leaves through shattering, and the crop is at no time exposed to weather hazards. Other companies are working on similar equipment.

At the present time many operators of hay driers are using the regular line of haying machinery—mower, side-delivery rake and loader—for harvesting the crop to be artificially dried. When this practice is followed the hay is usually allowed to lie in the swath or in the windrow for from 2 to 6 hours before loading. This is done partly to facilitate loading as the conventional hay loader does not always handle the freshly cut forage satisfactorily. The predrying effects a considerable saving in fuel consumption and increases the output of the drier.

PREDRYING

The saving of fuel made possible by predrying in the field for a short period during good drying weather is not to be ignored. Freshly cut alfalfa, for example, may contain 75 per cent moisture. This may be reduced by predrying to 60 per cent moisture content without appreciable loss of leaves. If a final moisture content of 10 per cent is desired, the predrying in this case would reduce the amount of water to be evaporated from 5200 to 2500 pounds per ton of dried product. The output of the drier would therefore be more than doubled by predrying from 75 per cent to 60 per cent moisture content. Whether any losses other than loss of leaves are incurred in sun drying has not been definitely determined. If predrying is permitted, care and judgment must be exercised in not mowing more hay than may be handled without danger of exposure to rain and dew. Otherwise the quality of the product will suffer.

COST OF ARTIFICIAL DRYING

The cost of the drying installations described in this paper varies anywhere from $6,000 to $25,000. The cost of artificially drying alfalfa has been figured anywhere from $3.50 to $10.00 per ton of dried hay. This includes depreciation of equipment as well as fuel, labor and power. The cost per ton of finished product depends very largely upon the amount of material dried and may be reduced by lengthening the drying season. Some of the driers operated in the northern states have operated from early June to October and produced over 1000 tons of dried hay in one season.

Use of Motor Trucks to Fight Rural Fires

By J. P. Fairbank[1]

THE motor truck has proved effective in the suppression of fires in the rural districts of California. Last summer one tank-pumper in the state division of forestry service controlled three miles of grass fire in forty-five minutes. Four pieces of motorized apparatus cost the state $4200 each, but during the period of July to December saved about $450,000 in property and labor. In addition to repaying their operating cost, they paid for themselves twenty fold in the half year.

A tank-pumper is essentially a simple piece of apparatus, merely a motor truck carrying a tank of water, some form of power-driven pump, hose, nozzles and an assortment of hand equipment useful for grain, grass and brush fire suppression.

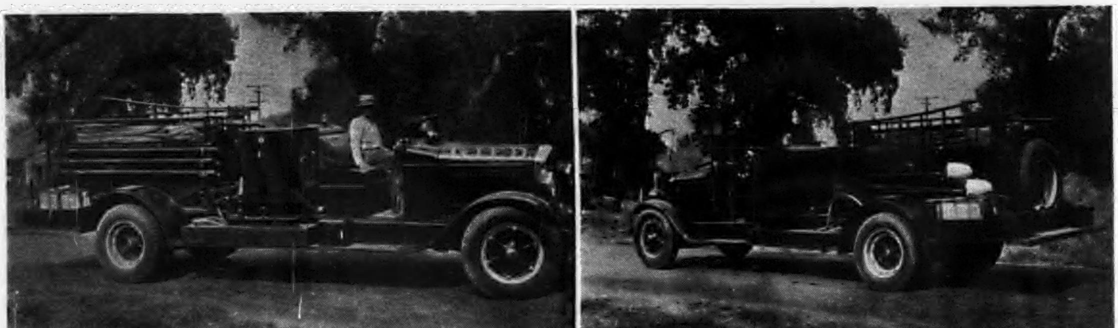
But simple as it is in principle, the design of successful rural fire-fighting machinery involves many problems in automotive construction, hydraulics and power transmission. The rural fire truck for this region of long dry summers should be capable of running long distances at high speed, pulling through fields, climbing hills, crossing ditches and levees and above all, withstanding abuse. These requirements involve special consideration of power, gear ratios, tire equipment, clearances, overhang, brakes and turning radius, assuming of course a chasis of sufficient capacity for the load (an ideal rarely achieved).

Water tank design is relatively simple, of course, but must be rugged, durable and of a shape which will result in a low center of gravity and permit mounting equipment so it will be quickly accessible.

The water pump must have ample volume and pressure capacity, be adapted to a wide range of speeds (if driven by the truck engine), have positive suction and, above all, be thoroughly dependable. The pump drive involves attention as to speeds, capacity, clutching and durability under continued operation.

[1]Extension specialist in agricultural engineering, University of California. Mem. A.S.A.E.

(Left) Fighting a grass fire with a tank pumper. Small streams of water at high pressure are used. (Right) A farmer-built tank pumper which has done excellent work on grain fires. The tank has a 500-gallon capacity and the pumping apparatus is a power sprayer



(Left) The Grand Island Fire District truck. Its large power spray pump direct connected to a 15-horsepower industrial engine is capable of throwing 30 gallons per minute at 400 pounds pressure. (Right) The other side of the same truck, showing additional equipment

Hose must not be too heavy for men to handle rapidly, yet must withstand high pressures and dragging over rocks, hot surfaces and fences. Nozzles should be adjustable as to volume and type of stream. The feature of quick shut-off to conserve water is important.

The mounting of equipment to provide for convenience, yet prevent loss or damage while the truck is bounding over fields, requires originality. Then too, provision must be made for carrying men safely.

The foregoing is an attempt to point out that the design of rural fire apparatus is worthy of consideration by agricultural engineers. You may rest assured that all of the problems have not been solved completely, but engineers can help the practical men who have been largely responsible for the progress which has been made.

Motorized apparatus for fighting grass and grain fires is another outgrowth of the World War. Back in 1917 many rural fire companies were organized as a part of the food-will-win-the war program. These companies were supplied with trailers loaded with hand fire tools including wet sacks, rakes, wire brooms and soda-acid fire extinguishers. Then similar equipment was mounted on motor trucks or rather passenger cars with truck bodies. Some farmers found that power sprayers were very effective for fighting grass and grain fires, and therefore power sprayers complete with water tank were mounted on motor trucks (usually overloaded for field conditions). Some fire wardens who objected to the weight of spray pumps and engines mounted light-weight forest fire pumpers on tank trucks with good results, except on those occasions when the tempermantal two-cycle engines of the outboard motor type refused to start. These proved the value of the system and now some of the new tank pumpers are equipped with complete pumping units powered by four-cylinder four-cycle engines of 10 to 20 horsepower. Some of the pumps are spray pumps of the plunger type, with capacities ranging from 15 to 35 gallons per minute at pressures up to 500 pounds, but many are rotary pumps of 70 to 150 gallons per minute capacity at 100 to 150 pounds pressure. For grass or grain fire work only 3 to 20 gallons per minute are used, yet the larger pump capacity is valuable for rapidly filling the truck tank or for pumping on structure fires from a source of water other than the tank.

A large percentage of the rural fire trucks built within the last three years drive the pump directly from the truck engine, either by means of a power take-off on the transmission or by clutching onto the front end of the crankshaft. Both methods have proved successful, but each has obvious disadvantages. The transmission-driven pump stops when the truck clutch is released for shifting gears, and the drag of the pump makes gear shifting difficult. With the front-end drive the pump does not stop while shifting gears and does not interfere with that operation, but some people object to the pump protruding 18 to 24 inches in front of the radiator with the consequent risk of damage by accident. Furthermore, lines of pipe or hose must be run between the truck body and the pump, involving some complication in mounting.

Some rural fire districts still use chemical tanks mounted on motor trucks, but these are in the main being replaced by water tanks and pressure pumps. To our knowledge no district has gone back to chemicals after trying water pumps, although good work has been done with the chemical outfits.

The trend is toward larger trucks, two-ton or larger, carrying 300 to 500 gallons of water. Improved motor truck design, including larger engines, four-wheel brakes and multi-speed transmission with provision for power-take-off has been a great help. However, auxiliary transmissions are still desirable on many models, especially where the pump is driven by the truck engine. Extraordinary engine to rear axle ratios in low gear are necessary, not only to turn the wheels under adverse conditions, but also to assure ample pump speed while the truck is moving slowly along a fire line.

An increasing variety of power-take-offs suitable for this service are being made available. More makes of small fire pumps suitable for this work are coming on the market. Several manufacturers can now supply reliable four-cylinder industrial engines of 10 to 15 horsepower. Manufacturers are entering the field of producing complete outfits. Their engineering and construction facilities should elimate some of the questionable features of "home-made" apparatus.

An impetus to the standardization of tank-pumpers has resulted from the recent action of fire insurance organizations to base their fire insurance rates for standing grain on the fire-fighting organization and equipment in the fire districts. We believe there is a field for smaller as well as for larger trucks. Four-wheel-drive and six-wheel trucks may prove superior to the conventional design for rural fire work. Equipment may be devised to use in connection with trucks to clear a trail in front of the fire. High-speed tractors may have a place in rural fire fighting apparatus.

Agricultural engineers can help the farmers, fire protection organizations, foresters and underwriters who are vitally concerned with the engineering problems of rural fire fighting apparatus.

AUTHOR'S NOTE: Interested persons may obtain copies of a very comprehensive treatise, entitled "Suggested Regulations of Rural Fire Departments and Suggested Specifications for Grass and Grain Fire Trucks," by writing to the Board of Fire Underwriters of the Pacific, San Francisco, Calif.

Factors Affecting Tank Type Milk Coolers[1]

By Earl M. Knepp[2]

ALL dairymen know that to produce good milk three things are necessary: Clean methods, clean utensils and rapid cooling. Rapid cooling is the most important of the three, if it is possible to put any one above the other two, because by rapid cooling it is possible to cover up some carelessness in the other two.

The tank or immersion-type cooler has developed very rapidly the last few years. At the present time there are at least seven or eight makes of tank-type machines on the market. Five different makes of tanks and machines were included in the study made on this type of cooler at Purdue University the past winter.

Studies were made on the effect of agitation of the cooling water on the rate of cooling, the rate of growth of bacteria in the milk, cost of operation and the amount of refrigeration lost through the sides of the tank in 24 hours.

The tanks used will be referred to by number as 1, 2, 3, 4 and 5. Tanks 1 and 2 were four-can boxes, tank 3 held six cans, and tank 4 was an eight-can size. Tank 4 was designed to be set in the ground, but this was impossible in this test. It therefore operated at a slight disadvantage. All the above tanks except tank 4 were insulated on the sides, ends and bottom with three inches of sheet cork, and on top with two inches of cork. Tank 4 had two inches of cork insulation on the walls and bottom.

Tank 5 was a concrete tank constructed especially for this test. It was a six-can size and was insulated on the sides, ends, and bottom with three inches of sheet cork, and on top with two inches of cork. This was the first tank of this design constructed.

All refrigeration machines with the exception of the machine on tank 4 were small machines with air-cooled condenser coils. The machine on tank 4 was larger and had a water-cooled coil.

METHODS OF COOLING STUDIED

Four combinations of temperature and movement of the cooling medium were experimented with, as follows:

1. Holding the water in the tanks at the lowest possible temperature—about 35 degrees (Fahrenheit).
2. Holding the water in the tanks at about 45 degrees.
3. Holding the water in the tanks at the lowest possible temperature with the agitator operating during the first two hours of cooling.
4. Holding the water in the tanks at about 45 degrees with the agitator operating during the first two hours of cooling.

Under each of the above methods the following systems were used:

1. The tanks were filled to full capacity at night.
2. The tanks were filled to half their capacity at night and half the next morning.

It was impossible to secure enough fresh milk to carry on the large number of tests made in this work, so warm water was used as a substitute. The specific heat of water is 1.000 and of fresh whole milk, 0.934. The two specific heats were so near the same it was not considered necessary to correct for the difference.

The temperature of the room where the tests were made was kept as near 80 degrees as possible. This is about the temperature of the average milk house during the summer months.

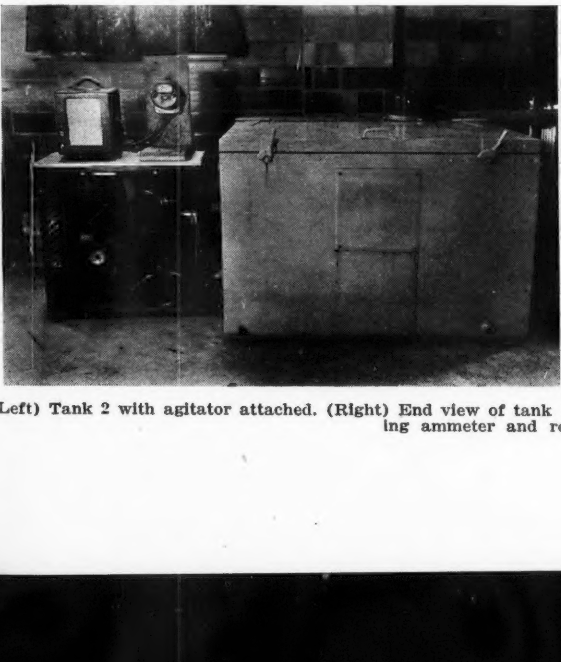
The agitator used was a vertically mounted motor connected directly to a shaft and a small propeller. The motor was mounted on top of the tank and the propeller extended down into the water, but was placed inside a piece of three-inch pipe. It operated by sucking the water through the pipe.

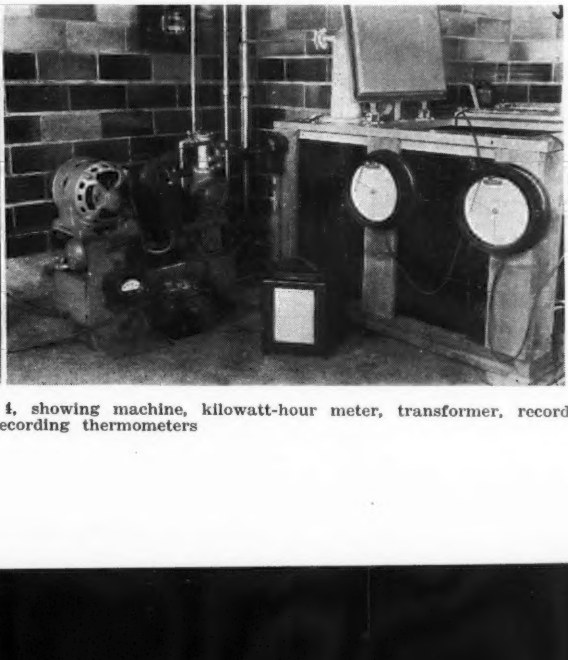
Temperatures were taken with recording thermometers. The bulb of one thermometer was placed in the center of the can and as near the surface as possible, and another was placed about one-fourth inch from the outside of the can at the surface of the water. Water used in the cans was heated to 95 degrees and poured into the cans which were at room temperature. The cans were immediately placed in the cooler.

RATES OF COOLING

Table I shows the rates of cooling obtained with the different tanks without the use of the agitator. Table II shows the rates of cooling obtained with the tanks operating under the same loads and conditions as those shown in Table I except that the agitator was used in the cooling water the first two hours after the warm water was placed in the tank.

The agitator increased the rate of cooling in every test. In many cases the milk cooled as much as two to three times as fast with the agitator as it did without it. When the agitator was used, in only one test did it require more than 60 minutes for the temperature of the





(Left) Tank 2 with agitator attached. (Right) End view of tank 4, showing machine, kilowatt-hour meter, transformer, recording ammeter and recording thermometers

[1]Abstract of a thesis prepared by the author as a requirement for the degree of master of science in agriculture.

[2]Graduate assistant in agricultural engineering, Purdue University.

TABLE I. Rates of Cooling when Agitator was not Used

No. of tank	No. of cans in test	Temp. of cooling water	Temp. of milk entering tank	Minutes required to cool to 60°F.	50°F.	40°F.	No. of tests made
1	4	40	95	105	345		2
1	2	40	95	75	195		8
2	4	36	95	70	195	540	15
2	2	36	95	65	155	450	4
2	4	35	95	77	185	510	3
2	2	35	95	55	120	330	4
2	4	45	95	210	570		12
2	2	45	95	160	360		2
3	6	35	95	115	345	750	2
3	3	35	95	75	155	360	3
3	2	35	95	60	105	195	4
5	3	40	95	75	210		4
5	6	37	95	90	300		2

Tank 4 could not be operated without the agitator.

TABLE II. Rates of Cooling when the Agitator was Used

No. of tank	No. of cans in test	Temp. of cooling water	Temp. of milk entering tank	Minutes required to cool to 60°F.	50°F	40°F.	No. of tests made
1	4	40	95	40	100		2
1	2	40	95	35	75		6
2	4	36	95	32	75	390	13
2	2	36	95	30	70	300	2
2	4	35	95	32	75	420	4
2	2	35	95	27	49	165	6
2	4	45	95	75	510		12
3	6	36	95	55	330		3
3	3	36	95	30	65	375	3
4*	4	35	96	42	65	138	4
4*	8	36	95	60	108	250	3
4*	8	40	95	60	123	720	4
4*	8	45	95	60	135		3
5	3	37	95	29	60	480	5
5	6	37	95	36	90		3

*Agitator on automatic control operating the compressor

milk to be lowered to 60 degrees. From a bacteriological standpoint this is important because bacteria in milk show little or no growth during the first hour after being drawn, and a temperature of 60 degrees is a critical temperature for their growth.

Prof. E. H. Parfitt of the dairy department, Purdue University, reports the following rates of cooling when the milk was precooled over a surface cooler before being placed in the tank-type cooler:

Temperature of the cooling tank	Temperature of the milk entering cooler	Minutes required to cool to 60 deg. F.	50 deg. F.	40 deg. F.
35	66	28	114	320
45	69	77	320	

By comparing Table II with these figures, it will be seen that the use of the agitator produced nearly the same rate of cooling as the surface cooler. This would seem to indicate the possibility of substituting the agitator for the surface cooler, the use of which is being objected to in many places on sanitary grounds.

Table III gives the number of kilowatt-hours required to remove 100 B.t.u., or to cool 100 pounds of milk one degree Fahrenheit. The amount used by the agitator is included where it is indicated that the agitator was used. There was a large variation in the amount of current used by the different tanks, even when they operated under the same conditions.

EFFECT OF AGITATION ON BACTERIAL GROWTH

All the tests in this part of the work were done with tank 2. This tank was selected because of its size and because of the satisfactory manner in which the agitator in this tank operated.

In order to operate the machine at full capacity and still not have to use four 40-quart cans of milk, glass tubes were made which were the same height as the cans.

TABLE III. Kilowatt-Hours Used by the Machines

No. of tank	No. of cans used	Ave. Temp. to which water in can was cooled	Water agitated	Kilowatt-hours used per 100 B.t.u. of heat removed
1	4	45 (deg.F.)	no	0.0485
1	4	39.5	2 hr.	0.0528
1	2	40.5	2 hr.	0.0550
1	2	43	no	0.0586
2	4	47.5	no	0.0391
2	4	47.5	2 hr.	0.0394
2	4	35	no	0.0442
2	4	35	2 hr.	0.0454
2	2	46	no	0.0343
2	2	46	2 hr.	0.0355
2	2	36	no	0.0417
2	2	36	2 hr.	0.0427
3	6	41	no	0.0207
3	6	43	2 hr.	0.0245
3	3	35	no	0.0226
3	3	35	2 hr.	0.0268
4	8	44	yes*	0.01475
4	8	36	yes*	0.0123
4	4	36	yes*	0.0190
5	6	42	2 hr.	0.0410
5	3	40	no	0.0264
5	3	37	2 hr.	0.0298

*Agitator operated on the same switch that controlled the compressor.

The amount used by the agitator is included where it is indicated that the agitator was used.

TABLE IV. Refrigeration Lost by Tanks in 24 Hours

No. of tank	Average number B. t. u. lost in 24 hours per square foot inside area	Refrigeration lost by the tank in 24 hours, in terms of pounds of ice
1	128.20	57.70
2	162.50	61.50
3	158.64	65.20
4	203.16	95.20
5	102.16	48.00
5*	110.62	51.47

*The two inches of cork board in the lid was removed when this test was made.

The room temperature where the tests were made was kept as near 80 degrees as possible.

These tubes were about one-half inch in diameter and each held about 200 cubic centimeters. They were filled with milk and placed in the center of the cans of water after the water had been heated to 95 degrees. They were held in the center of the cans by wires fastened to the sides of the cans. After the tubes were placed in the cans, the cans were immediately immersed in the cooling tank and left for about 14 hours or over night. In half the tests made at each temperature the water around the cans was agitated with the agitator for the first two hours. In the other tests the agitator was not operated, but the milk was allowed to cool by transmission of the heat through the sides of the can into the cooling water.

It was felt that by using the tubes of milk in the center of the can, the same conditions would be obtained as when a sample of milk is taken from the center of the can with a long sample tube. Here milk is taken from the center of the can which is supposedly the warmest portion of the can. It is probable, therefore, that the sample we used was held under the most favorable conditions for bacterial growth. Another advantage to be gained by using the tubes for the milk is that it is much easier to get a good representative sample to be used in making the bacteria counts from the small amount of milk contained in the tubes, than from large cans of milk. We are also sure that the samples taken in the morning are from the same milk as that from which the samples at night were taken.

Two sets of data were taken, one with the machine set to hold the cooling water at 35 degrees and the other at 45 degrees, twenty-four tests being made at each temperature, twelve with the agitator and twelve without it. Plate counts were made on the milk when it was put

into the tank at night, and again when it was taken out the next morning.

In the test with the tank held at 45 degrees, an average of twelve tests gave a bacterial growth factor of 1.48 when the agitator was operated the first two hours after the milk was placed in the tank. When the agitator was not used an average of twelve tests gave a growth factor of 3.704. This indicates that when the agitator was not used the bacteria grew two and one-half times as fast as they did when the agitator was used.

With the tank operated at 35 degrees an average of twenty-two samples show that milk which contained less than 60,000 bacteria per cubic centimeter when it was placed in the tank showed practically no growth in 14 hours either with or without the agitator. Some high growth factors were obtained on milk which contained more than 90,000 bacteria when it was placed in the cooler.

It required 1.76 kilowatt-hours to cool 100 pounds of milk to 45 degrees with this tank, and 2.436 kilowatt-hours to cool the same amount of milk to 35 degrees. Therefore, the dairyman would have to receive a good bonus for his milk before he could afford to cool it to 35 degrees. If care is taken so that the milk contains a small number of bacteria when placed in the cooler, and if the water is agitated, operating the tank at 45 degrees should control the growth of bacteria for 14 to 16 hours satisfactorily.

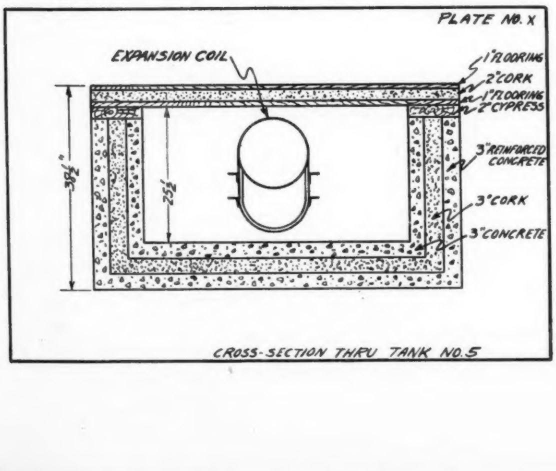
REFRIGERATION LOST THROUGH SIDES OF TANK

One of the important items to be considered in any type of refrigerator is the insulation of the refrigerated chamber. Different types of materials differ from each other in the rate at which heat will diffuse through a given thickness for a given difference in temperature. Heat will go through a one-inch thickness of dry concrete about eight and one-half times as fast as through a one-inch thickness of wood and about twenty-six times as fast as it will go through one-inch thickness of dry cork board.

Water is a poor insulator. For this reason, it is important that any insulating material should be thoroughly waterproofed with a thick coating of waterproof asphalt before it is built into the bottom and walls of milk tanks. If the insulation becomes wet, it will cease to insulate as well as it did when dry, and as a result the refrigeration machine will have to operate more hours and may be unable to keep the tank cool.

After the milk stored in a cooler has been cooled down to the desired temperature, it is then merely a question of supplying sufficient refrigeration to control the heat which finds its way through the walls, top, and bottom of the box. The third part of this project was undertaken to measure this loss.

In order to measure the amount of refrigeration lost a weighed amount of ice was put into the tank which had been previously filled with a weighed amount of tap water, and records kept as to the B.t.u. used and heat lost by the tank.



CROSS-SECTION THRU TANK NO. 5

Three 10-hour tests and three 14-hour tests were made on each tank. The 10 and 14-hour tests were alternated, each 10-hour test being followed by a 14-hour test so that the two made up 24 hours. The six tests on each tank were run consecutively in a three-day period.

The tanks were put under as near operating conditions as possible. They were filled to their rated capacity with 40-quart cans filled with water at 95 degrees. Enough water was put in the tank so that, when the ice was added, the water was 20 inches deep and came up around the neck of the cans. The water put into the tanks was weighed at the beginning of the three-day test. After each test enough water was taken out of the tank to equal the amount of ice added, so that each test was made with the same amount of water in the tank. Room temperature was held as near 80 degrees as possible.

Enough ice was weighed and put into the tank to cool the water and hold it at as low temperature as it was possible to obtain for the entire period. Care was taken to have enough ice in the tank so that some would be left at the end of the period. The ice which had not melted at the end of the test was taken out, weighed and this weight subtracted from the amount of ice put in to get the amount of ice used.

Following are the factors to be considered in determining the heat losses of immersion-type milk coolers.

1. Animal heat from the milk (which in this problem refers to the heat removed from the warm water in the cans).

2. Heat removed from the cans.

3. Heat removed in lowering the temperature of the cooling water, if it is lowered.

4. Removal of the heat which enters the tank through the sides, top, and bottom.

Ice removes heat by (1) heat of fusion, and (2) by rise in temperature from the melting point to the final temperature of the water. Therefore, the following formula represents the heat removed by ice:

pounds ice $= 144 + (T - 32°)$

Results of the tests on refrigeration lost by the tanks are shown in Table IV. Two sets of tests were made on tank 5, one with two inches of cork in the lid and the other with the cork removed and a two-inch air space in the lid. The cork in the lid seemed to make very little difference in the amount of refrigeration lost. The importance of the refrigeration lost through the sides of the tanks is shown by the fact that in terms of ice no tank lost less than 48 pounds in 24 hours. This is in spite of the fact that all tanks except tank 4 were insulated with three inches of cork board. Tank 4 had two inches of cork insulation.

SUMMARY

1. The use of the agitator greatly increases the rate of cooling obtained by tank type coolers.

2. It is possible to cool milk from 95 to 60 degrees, and below in the tank-type coolers using the agitator, in the same time that is required to obtain the same temperature in surface-cooled milk placed in a tank without agitation.

3. When the tank operated at 45 degrees, the agitator greatly reduced the rate of growth of bacteria. Operating the tank at 35 degrees greatly increased the cost of operation, and would not be justified except where the dairyman received a good bonus for his milk, or had to ship it long distances.

4. The number of kilowatt-hours used for each 100 B.t.u. of heat removed varied with the different machines, and temperatures to which the milk was cooled, from 0.0583 to 0.0123.

5. Even in well-insulated tanks the refrigeration lost through the sides of the tank was from 48 to 90 pounds of ice for each 24 hours.

Farm House Conditions and Needs[1]

By Deane G. Carter[2]

IN ORDER to design and plan farm houses adapted to needs, it is necessary that information be made available indicating the actual conditions prevailing in the farm house. Such information is presented in this paper, and is prepared from studies made by the Arkansas Agricultural Experiment Station from 1926 to 1930[3].

The data are presumed to be typical of the established farm home in Arkansas. Five areas in the state were studied, and altogether 515 farm homes were visited. Four-fifths were owner homes; one-fifth were occupied by tenants. Comparisons with questionnaire records from several states[4], and published data tend to substantiate the facts presented[5].

Size of Farm. Table I indicates the range of farm sizes on which the homes were located. It is significant that quality of housing, as indicated by size and equipment increases distinctly at the 120-acre size, and is quite closely correlated with the size of farm.

Location of Homes. The location of the house with respect to the site is limited by the topography and by natural factors such as water supply and drainage. Six per cent of the homes were located where approach from the road or highway was difficult. About half were located on a level site; a third on the highest nearby ground, or hill top; a tenth on hillsides or slopes; and a very few in low valleys or depressions. No differences were observed in the direction in which the house faced.

[1]Research Paper No. 207, Journal Series, University of Arkansas.

[2]Professor of agricultural engineering, University of Arkansas. Mem. A.S.A.E.

[3]Credit is due Madge Johnson, formerly research worker in home economics, for the collection of data and part of the tabulations.

[4]Unpublished data, agricultural engineering department.

[5]Kirkpatrick, E. L. Housing conditions among 947 white farm families of Texas. U.S.D.A. Preliminary Report, 1926. Grey, Greta. The Nebraska Farm Kitchen, Nebraska Agricultural Experiment Station Bulletin No. 226, 1928. Cornell, Jr., F. D., Farm Water Supply and Sewage Disposal in West Virginia, West Virginia Agricultural Experiment Station Bulletin 206, 1926.

Construction Features. The foundation construction was continuous masonry in about half the cases and wood or masonry piers in the remainder. Interior wall finish was lacking in 11.26 per cent of the cases; wood ceiling occurred in 81.94 per cent; and plaster or wallboard in about 7 per cent of the homes. Practically all of the homes were typical frame construction. Basement or cellar space was found in 5.24 per cent of the houses; clothes closets in 32.03 per cent; and kitchen cabinet storage in 56.70 per cent of the cases.

Natural and Artificial Lighting. Ward[6], from an analysis of 50 plans prepared by agricultural experiment stations, concluded that, in general, the ratio of window area to floor area should be approximately 1:6, or the window area should be equal to 16⅔ per cent of the floor area. Common practice indicates ratios of from 1:6 to 1:8. In the homes studied, the natural lighting is definitely below the usual standard as indicated by Table II.

Data were obtained on the type, but not the amount of artificial lighting. Eight per cent had electricity; 3.9 per cent, gas; 5 per cent, mantle lamps; 83 per cent, ordinary kerosene lamps. Gray[7] found that the intensity of illumination (in Nebraska homes) lighted by kerosene and gasoline lamps was far below the standards set by illuminating engineers.

Utilities and Equipment. The results are summarized in Table III.

Of the items in Table III power washers, furnace heating, mantle lamps and gas lines may not be indications of a modern situation. It may be assumed that the completely modern house should have most of the items. It will be noted that the number of bathrooms is greater than the number with water supply and indoor toilets. Probably certain homes were equipped only with bathtubs at the time the survey was made.

Water Supply. A supply of running water is generally regarded as the primary essential. Twelve per cent

[6]Ward, W. G., "How Far Should the Farm House be Standardized," AGRICULTURAL ENGINEERING, Vol. 8, p. 172.

[7]Gray, Greta, "Lighting with Portable Lamps," Nebraska Experiment Station Bulletin 225, 1928.

TABLE I
Comparison: Size of Farm and Size of House and Equipment
(515 Arkansas Farm Homes)

Size of Farm, acres	No. of Cases	Area of House, sq. ft.	Per Cent with Running water	Per Cent with Electricity
Less than 39.9	44	958.98	4.54	0.0
40 - 79.9	100	945.83	6.00	3.00
80 - 119.9	121	1053.60	2.47	0.82
120 - 159.9	61	1226.59	9.83	3.27
160 - 199.9	72	1315.77	12.50	13.37
200 - 239.9	32	1369.75	31.25	21.87
240 - 279.9	15	1294.46	26.66	6.66
280 - 319.9	23	1322.17	8.69	13.04
320 - 359.9	8	1508.50	50.00	12.50
360 - 399.9	3	1389.20	33.33	0.0
400 - 799.9	26	1578.61	42.30	42.30
800 or more	10	1403.20	50.00	30.00

About 10 per cent of the homes are modern in finish, water supply, plumbing and lighting. The best houses are found on the larger farms

TABLE II
Ratio of Window Area to Floor Space
(515 Arkansas Farm Homes)

Room	No. of Cases	Ratio
Living room	374	1:9.52
Dining room	322	1:11.45
Kitchen	515	1:11.00
Largest bedroom	515	1:10.49
Second bedroom	455	1:10.83
Third bedroom	278	1:10.62
Fourth bedroom	118	1:10.30

TABLE III
Utilities and Equipment
(515 Arkansas Farm Homes)

Item	No. of Cases	Per Cent of Total
Furnace heating	3	.58
Bathroom	54	10.50
Water in house	63	12.20
Indoor toilet	31	6.01
Kitchen sinks	66	12.80
Gas	20	3.90
Mantle lamps	26	5.00
Electricity	43	8.30
Oil or gas stoves	106	20.60
Improved irons	37	7.20
Power washers	24	4.10
Refrigerators	94	18.30
Telephone	381	73.90
Sewing machine	424	82.30

TABLE VI
Size of House
(515 Arkansas Farm Homes)

Size, sq. ft.	No. of Cases	Per Cent of Total
Under 399	3	0.58
400 - 799	92	17.90
800 - 1199	196	38.00
1200 - 1599	151	29.22
1600 - 1999	57	11.10
2000 or over	16	3.10

TABLE IV
Age of Farm Houses
(515 Arkansas Farm Homes)

Age	Per Cent of Total
Under 10 years	23.47
10 - 19	25.82
20 - 29	21.74
30 - 39	12.42
40 - 49	9.51
50 or more	6.99

TABLE VII
Number of Rooms per House
(515 Arkansas Farm Homes)

Number of Rooms	Number of Cases	Per Cent
2	12	2.33
3	43	8.35
4	102	19.80
5	132	25.60
6	130	25.22
7	48	9.30
8	31	6.00
9 or more	17	3.30

TABLE V
Length of Residence in Present House
(515 Arkansas Farm Homes)

Years Residence	No. of Cases	Per Cent of Total
Less than 10	276	53.58
10 - 19	106	20.58
20 - 29	59	11.45
30 - 39	38	7.37
40 or over	36	6.99

The average age of the houses studied was 22 years. This one is 50 years old

had water in the house. Over two-thirds of the sources of supply were open and presumably exposed to contamination. Likewise in nearly two-thirds of the cases the "rope and bucket" method was used to obtain water. In 85 per cent of the cases, the water source was within 30 feet of the house, a favorable situation for the addition of a water supply system.

Sewage Disposal. Six per cent of the houses were equipped with indoor toilets; less than six per cent had complete septic tank sewage disposal. Some 19.6 per cent had no toilet facilities at all. This situation, together with the common lack of window screens[8], and the number of open wells indicates a health menace similar to that observed elsewhere[9].

Age of Farm Homes. The age of the homes studied is indicated by Table IV. The calculated average age was 22 years. It will be noted that approximately one-fourth of the homes occur in each group: 10 years or less; 10 to 20 years; 20 to 30 years; and over 30 years. Roughly this indicates a need for new homes at the rate of 2½ per cent of the total each year. On the basis of 220,000 farms in the state, 5500 new houses a year would be required.

Time Occupied by One Family. .There is naturally a much more rapid change of residence among tenants than among owners. Ninety-four per cent of the tenants and 53 per cent of the owners had occupied the present house less than 10 years. Averages were 3.2 years per house for tenants, 15.37 years for owners, and 13 years for all.

The distribution by length of residence is shown in Table V. Tables IV and V indicate that while 76.53 per cent of the houses are over 10 years of age, 53.58 per cent of the families had changed residence in less than 10 years. Half the homes were less than 20 years old; three-fourths of the families had lived in the present house less than 20 years. The average length of residence was 13 years; the average age of house, 22 years. This indicates a need for designs to accommodate a succession of families.

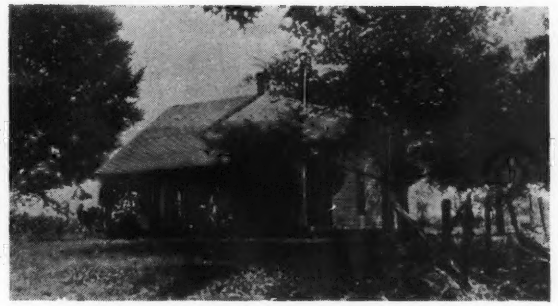
The Size of the House. House size may be measured by the total floor area or by the number of rooms per house. In neither case can the average figures be interpreted other than to indicate a trend or tendency. Table VI indicates the distribution according to size. The average area per house was 1169.74 square feet. Nearly one-fifth of the families lived in homes obviously smaller than desirable under any conditions. In all, the average area is 251 square feet less than the area of 245 commercial stock plans analyzed.

[8]A survey of 431 homes in one Arkansas county indicated approximately 31 per cent of the houses screened.

[9]Public Health Reports, Vols. 41, No. 43, Oct. 22, 1926, p. 2409.

TABLE VIII
Size of Family and Number of Sleeping Rooms
(515 Arkansas Farm Homes)

Size of Family	No. of Cases	Per Cent of Total	Number of Bedrooms per House 1	2	3	4	5	6	7	8	9	Average share of bedroom for each person
1	2	0.38	1	1								1.50
2	96	18.64	12	40	26	10	8					1.30
3	95	18.44	16	36	23	15	3	2				0.86
4	100	19.41	13	32	34	12	7					0.70
5	73	14.17	6	24	26	9	5	3				0.58
6	50	9.71	5	14	21	4	5	1				0.48
7	45	8.73	3	16	11	10	2	2	1			0.43
8	26	5.04	1	4	10	7	3	1				0.42
9	10	1.94		5	2	2		1				0.33
10	10	1.94		3	6			1				0.30
11	2	0.38		1		1						0.27
12	3	0.58			1	1	1					0.33
13	1	0.19			1							0.23
14	2	0.38			1		1					0.29



The one-story house with a central hallway and two or three rooms on each side is typical

In comparing room areas with commercial plans it was found that the farm living room was smaller, but the kitchen, dining room and principal sleeping room of the farm house averaged larger than in the commercial plan.

According to the number of rooms in the house, the distribution found is shown in Table VII. The average number of rooms per house was 5.35, with the four, five and six-room houses predominating. Since the average number of persons per family was 4.57, the commonly accepted standard of one room per person was apparently met. However, there was no correlation between the number of rooms per house and persons in the family.

Adequacy of Sleeping Room Space. In 140 cases, or 27 per cent, there was a combination of living room and bedroom. This occurred in 66 per cent of the two-room houses, 70 per cent of the three-room houses, 42 per cent of the four-room houses, and 20 per cent of the five-room houses, indicating an apparent deficiency of bedroom space, especially in the smaller houses. Table VIII indicates the prevailing conditions with respect to sleeping rooms.

The conclusion to be drawn from this data is that the small family has ample bedroom space; the family of average size has sufficient space; the large family has an insufficient number of sleeping rooms. The figures below and to the left of the irregular line drawn through Table VIII indicates those families with less than the normal one bedroom for each two persons. There are 150 cases in this group. No provision for a guest room has been considered. If a spare room in addition to the family needs were considered as essential, 295, or 57.5 per cent, would be inadequate. In an extreme case, it was found that one family of eight members had but one sleeping room. In two instances a nine-bedroom house was occupied by a four-person family. Obviously these houses were not fitted to the family requirements. The analysis does not take into account sleeping room requirements based upon age, sex or relationship.

SUMMARY

1. The data given represent averages of 515 typical established farm homes in five areas of Arkansas. Data were obtained by personal investigations.
2. Quality of housing, as measured by size and equipment, tends to increase with an increase in the size of farm.
3. There is a distinct increase in facilities and size of house on farms of 120 acres and over.
4. No definite trends of location were found.

5. House construction is typically frame, with a lack of basement, storage and kitchen cabinet space. One-half of the houses have insufficient foundations.
6. The natural and artificial lighting is inadequate as compared to usual standards.
7. The better homes are partially equipped with labor-saving and convenience facilities. In general, however, provision for sewage disposal, safe running water supply and power appliances represents a major problem.
8. The average age of the houses is 22 years, with a probable new construction of about 2½ per cent of the total each year.
9. Average length of residence in one house is 12 years. Owner homes are occupied by three or more families during the useful life of the house. Tenant families change each three years, as an average.
10. The farm houses average 250 square feet smaller in floor area than typical commercial plans. One-fifth are obviously inadequate in size; the average is 1169.74 square feet.
11. The majority of the houses have four, five or six rooms each, with 5.35 rooms the average. This is approximately one room per person, based upon averages, but there is no correlation between size of house and size of family.
12. Sleeping room space is insufficient. In 27 per cent of the cases the living room counted as a sleeping room, 150 or nearly one-third of the families had less than one sleeping room for each two persons.

Basic Factors in Farm Home Planning[1]

By Deane G. Carter[2]

THE design and planning of the farm home is limited by certain basic factors that must be observed, in addition to the architectural and construction features. The factors derived in this paper are based primarily upon a study of 515 farm homes made by the Arkansas Agricultural Experiment Station. In addition to the material presented herewith, much of the data is included in the study, entitled "Farm House Conditions and Needs[3]".

I. The house must be designed for the farm of which it becomes a permanent part. A house is a part of the real estate to which it is attached, and is so recognized in the courts. In a town or city of any size, there is a sufficient choice available that any family may own or rent a house adapted in size, cost, location and quality to its own needs. Usually the farm home is occupied by the operator irrespective of its adaption to individual needs.

The range of size of family was found to be from one to 14 persons; the average length of residence thirteen years. It was further noted that there is a tendency for the quality of house (measured by size and equipment) to improve with the increased size of farm. The houses studied were on farms of from three acres to more than 1000 acres. It is not possible to take account of family needs, except in general terms. To some extent at least the investment in housing must be proportioned to the farm investment.

II. The farm house must be designed to be occupied by a succession of families with varying needs, or for one family through a series of changing requirements. In a large group of cases about one-fifth of the operators are classed as beginners, three-fifths as established, mature or middle aged, and one-fifth elderly. Should one family occupy the farm for many years, there is a change in the number of persons, financial status and desires. Tenants move, on the average, every 3.2 years; owners, every 15.37 years. The present home had been occupied less than 10 years by 43.69 per cent of the owners and 94.05 per cent of the tenants. Since the house can be expected to outlast the period of occupancy by one family, a standard or typical construction may be more suitable than a special design. This is especially true of houses to be occupied by tenants.

III. The house must be designed for the purpose intended, or for the class or group that will occupy the house. The census classification shows both white and colored farmers as owners, part owners, managers, cash renters and share croppers. Forty-four per cent of the farms are occupied by owners; 56 per cent, by tenants. There are individual differences to be taken into account, among the members of each group, in addition to the standard of housing that may be set up for owners, managers, tenants or share croppers.

IV. The cost of the house and the ability to pay represents the most important factor and probably the most positive limit in farm housing. The value of all farm buildings in Arkansas was approximately 120 million dollars in 1925, according to census figures. There are 220,000 farms in the state, or $540 worth of buildings per farm. If the common assumption is made that the house represents one-half the total building value, the amount would be $270 for the house. This amount is far below the replacement value of the very plain two-room house, without utilities or mechanical equipment.

The so-called "modern" house, well built, with good quality finish and equipped with the principal utilities, costs 21.5 cents per cubic foot under Arkansas conditions. Since few of the houses studied were constructed or equipped to this standard, the conclusion is reached that cost was one of the important limits. Men experienced in house design know that one of the major problems is to provide the quality desired within the cost limit set.

A common standard of housing costs for persons on salary has been given as "the investment in the house should be equivalent to two or two and one-half year's salary." According to the department of rural economics and sociology, University of Arkansas, the average gross receipts per farm in the state amount to approximately $1200 per year.

V. The equipment and utilities for health, sanitation, comfort and labor saving must be the individual responsibility of the owner. Less than 20 per cent of the homes studied were equipped with any of the usual features of plumbing, water supply, electricity or labor-saving equipment. With the exception of electricity, most of the facilities may be provided at no increase in cost over the cost in city homes. Nevertheless the design of the farm home must take account of the necessity for individual effort to provide the equipment in the home.

VI. The specifically rural needs are of minor importance as compared to the general requirements of housing. It is evident that the farm house is, in a majority of cases, inadequate in mechanical equipment, sleeping room space, and quality of finish. A large proportion are of four, five and six rooms. In many cases (about one-third) combinations of living and bedroom, or dining room and kitchen are found. Comparisons with typical stock plans indicate a lack of numerous features considered desirable. The cost of housing and the limited income per farm restrict the house to the essentials of housing. It seems impossible to consider the rather common published recommendations of office room, wash room, large dining room and additional size.

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[1]Research Paper No. 208, Journal Series, University of Arkansas.

[2]Professor of agricultural engineering, University of Arkansas. Mem. A.S.A.E.

[3]Published in this issue, page 304.

Some Legal Principles of Farm Construction

By J. D. Long[1]

THE legal principles of farm construction work should form a part of the mental background of every agricultural engineer interested in the farm structures field. Such knowledge is an important adjunct to his work and is necessary to a complete consulting service to the farmer.

In engaging in construction work the farmer enters a field where requirements, limitations and responsibilities of the various contracting parties have been very fully, and often confusingly, defined by law. In all cases where labor other than his own or that of regular farm laborers already protected by casualty insurance is involved, and where the securing of materials or equipment is a complicated procedure, a full understanding of the law and the protection it affords him from unscrupulous or inefficient builders and dealers is advisable. It is true that most building work is done on honor, but there are always chances for mistaken conceptions, misunderstandings or "acts of God" misfortunes which may cause rifts in what have been peaceful and enjoyable business relationships.

The only general advice which can be given is, first, "see a lawyer," and then deal only with those builders whose integrity, ability and financial responsibility are of a high quality. Business laws represent a constantly accumulating mass of detail wherein a layman flounders hopelessly. Laws vary between states. Securing reputable legal advice, preferably from a local lawyer, is usually the cheapest form of insurance against legal mishap and added financial burden.

To cooperate intelligently with the lawyer, and especially, to properly rate the value of services rendered by one, some general principles should be understood. The explanatory material which follows is based on the California statutes but is, in the main, applicable to all other states as well The outstanding differences are usually those of procedure, the general intent is the same.

Liability. In the eyes of the law there is no fundamental difference between urban and rural construction.

When a structure is erected on a property, that unit of property itself serves as collateral and may be sold to satisfy claims of building creditors, either mechanics or material dealers. This is an especially important item for the absentee owner whose lessee improves his property with structures. If erected with the owner's knowledge, the property on which the structure is erected becomes liable in case the lessee defaults payments, unless the owner has taken the precaution of filing a "no liability" notice with the county recorder and posting such a notice on the property where it may be read by the builders and material dealers.

On a contract job, if the owner has properly recorded the contract, plans, specifications and bond, as hereinafter noted, he cannot be held to pay more than the price specified in the contract. If all the provisions noted have not been met the owner may become liable in part or in full for all obligations, not to exceed, however, the value of the unit of property on which the structure was erected. In such a case the farm may be sold to satisfy claims of laborers and material men against a building which has been erected on it, but if the sale price is not sufficient to cover the claims no other part of the original owner's property may be touched.

If an owner hires the work done under his supervision without contract he is responsible as the contractor, whose place he is taking, for all bills and claims without limit.

[1]Junior agricultural engineer, University of California. Assoc. Mem. A.S.A.S.

In all cases the contractor should satisfy himself as to the ownership and approximate value of the land in which he is to build.

Contracts. Most construction work is carried out on a contract basis between the owner and some skilled mechanic or contractor. The contract is composed of a written agreement signed by the two parties, wherein the nature and quality of the work (defined by the attached plans and specifications), the time of completion, amount and method of payment, responsibility of the two parties, and other sundry items are defined. The plans and specifications form an integral part of the contract.

In place of dealing with one general contractor, the owner may let a number of contracts to several individuals representing various mechanical trades. If it is desired to secure competitive bids from several contractors, the necessity of having exact plans and explicit specifications, that all bidders may figure on comparable work, is readily appreciated.

Contractor's Bonds. As a part of the contract, or several individual contracts, it is advisable to specify that the contractor shall provide bonds Although frequently grouped into one, these have a dual character, one for a materials and labor bond, and the other a contractor's bond. The former is a guarantee that the contractor, or his bonding company, will be responsible for all material and labor charges contracted for the particular job in question. The latter is a guarantee that the contractor will complete the structure, or that the bonding company will have it completed by other contractors in case he defaults without exceeding the contract price. The cost of these bonds are, of course, added by the contractor to his contract price. Except under very unusual conditions, it is poor economy to fail to secure the insurance provided by the bond.

Recording Contract. Laws vary, but in California and many other states the owner may file with the county recorder a copy of the contract with attached contractor's bond and the plans and specifications prior to the inception of the work. This is for his own protection and insures that his liability will be limited to the contract price. Otherwise, his financial responsibility may be limitless. Even though he has exacted (and paid for in his contract price) the regular contractor's bonds, if the bonding company is financially responsible at the time of filing the procedure of filing protects him from the possibility of much legal controversy in case of claims, and renders him free of all claims even in the event both contractor and bonding company go bankrupt. It should be noted that this recording must be made before the work starts.

Mechanic and Material Liens. In the extreme event where the contract has not been properly recorded, no bond exacted of the contractor, and misadventure leads to the securing of a dishonest contractor, the owner may be fully liable for all laborers' wages and materials entering into the construction. If such payments as he has made to the contractor during the course of the work have been misappropriated and no payment made to the mechanics and material dealers for the building in question, the owner is liable to the full extent of these bills. The filing of attachment to collect these unpaid bills is termed a mechanics' or Materials' lien.

Thus, his structure may cost the owner considerably more, and up to approximately twice, the original contract price. The procedure of recording the contract, which has been described, fully protects the owner against this rather common occurrence.

Workman's Injury Liability. Under the provisions of the workman's compensation law in force in most states

a disabled workman may lay claim for his injury before the state workman's compensation board. The claims allowed may be assessed against both contractor and owner. In case the injury is due to gross neglect or carelessness on the part of the contractor or owner, the workman may waive the relatively small claims allowed by the workman's compensation board for the general run of industrial accidents and sue for damages in proportion to the extent of his injury. In case of serious accidents this may amount to a staggering sum.

If the work is being done by the owner serving as his own contractor, he should be fully protected by employee liability insurance. If the work has been let by contract, the written contract should specify that the contractor be fully protected by such insurance and the owner should make certain this provision has been carried out before the work is undertaken.

Fire Insurance. Another form of protection which should be carried by the owner is fire insurance. Insurance companies are now writing policies encouraging the insuring of structures under construction by publishing a 39-months' policy at a 3-year rate, thus allowing for coverage over a three month erection period free of insurance charge.

Payments to Contractor. The contract between owner and contractor should specify explicitly the method of payment to be employed. This usually is a "step" payment, fractions of the contract price being paid upon completion of various units or parts of the construction. Thus, one-fourth the contract price may be paid when the structure is half completed, one-fourth when three fourths of the work is completed, one-fourth when the completed structure is accepted by the owner, and the final one-fourth when the period for the filing of all mechanics' and materials' liens has been passed. Other methods of payment and other fractional payments, may of course be specified.

Acceptance of Structure. When a contract job is completed, the owner may denote acceptance verbally or by occupancy. The latter has frequently caused throuble; the owner should be careful to make no use of the structure until such time as he is ready to accept it, as occupancy implies acceptance. Refusal to accept when the contractor considers the building completed must be based on some real grounds for refusing the structure such as failure to meet the terms of the contract or failure to follow the plans and specifications. A court will not allow trivial imperfections and slight differences in the interpretation of specifications as sufficient grounds for refusal to accept a completed structure.

Notice of completion of the structure should be filed with the county recorder by the owner within ten days after acceptance; this outlaws any mechanics and materials liens placed later than thirty days thereafter. If completion notice is not filed, mechanics and materials liens may be placed against the building for a period of ninety days after the date of completion

AUTHOR'S NOTE: Acknowledgement is made of the assistance rendered in the preparation of this manuscript by Leslie Childs, counselor at law and law writer of Indianapolis, Ind.

What Type of Corn Cultivator?

By Eugene G. McKibben[1]

AN OBSERVANT trip from Ames, Iowa, to State College, Pennsylvania, through the so-called corn belt the second week in June, forced the following rather uncomplimentary conclusion: Either the higher capacity modern corn cultivating equipment is not all agricultural engineers claim it is, or agricultural engineers have so far failed to demonstrate its merits to the satisfaction of the average American farmer.

During this trip, which was made by automobile, mostly along the Lincoln Highway, a careful record was kept of all cultivating equipment which was seen in actual operation. The following table gives the results which speak for themselves:

	Half-row walking one-horse cultivators	Single-row walking cultivators	Single-row riding cultivators	Two-row horse-drawn cultivators	Two-row tractor cultivators	Total
Iowa	0	18	130	8	2	158
Illinois	0	9	125	11	2	147
Indiana	2	7	31	0	0	40
Ohio	2	11	96	18	0	127
Pennsylvania	0	3	15	0	0	18
Total	4	48	397	37	4	490
Per Cent	0.8	9.8	81.0	7.6	0.8	100

It should also be added that five of the single-row walking cultivators had a boy riding on an improvised seat and driving the team, in addition to the operator who was walking. This may have been just a matter of keeping the boy busy rather than an admission of lack of ability on the part of the operator.

[1]Associate professor of agricultural engineering, The Pennsylvania State College. Mem. A.S.A.E.

In addition to the row cultivators, only one spiketooth harrow, two rollers and six rotary hoes were seen in use. This was in spite of the fact that most of the corn was still small enough for the use of this type of equipment.

Of course, the fact that many of the fields were being cultivated for the first time may help to explain the small number of two-row cultivators. However, to an agricultural engineer, more single-row walking cultivators than two-row cultivators and as many half-row walking one-horse cultivators as tractor cultivators does not seem to be the proper ratio. These half-row one-horse walking cultivators were not in truck patches but in actual corn fields in Indiana and Ohio.

The fact that there appeared to be a very definite correlation between the use of higher capacity, modern cultivating equipment and the appearance of prosperity seemed to support the contention of our profession that this equipment is both mechanically and economically feasible. Yet a cynic can always raise the question of whether the prosperity is the result of modern equipment or the modern equipment is the result of prosperity.

Anyway it is very evident that one or more of at least the following are badly needed:

1. More complete investigation of the relative possibilities and limitations of higher capacity cultivating equipment.

2. Increased effort to adapt this higher capacity equipment to adverse farming conditions.

3. More thorough demonstration to the average farmer of the economic possibilities of this equipment and of methods of its efficient use.

Certainly if two to four-row cultivators, rotary hoes and springtooth weeders can be successfully used, a man who uses a one-half-row one-horse walking cultivator or who operates a one-row walking cultivator and requires aid in its operation cannot expect to become a prosperous and successful farmer even with government aid.

Effects of Corn Borer on Production Methods[1]

By R. H. Wileman[2]

THE general-purpose tractor is rapidly coming to be more and more a factor in the production of our annual corn crop. Almost simultaneous with this type of tractor came the European corn borer. It has since become well known that mechanical destruction of the corn borer larvae between harvest time and the following June is the only proven control for this pest on a commercial scale. How well the general-purpose tractor will adapt itself to use under these conditions is problematical.

A project to determine the cost of corn production by mechanical methods under federal corn borer clean-up regulations was started last year at Purdue University. A general-purpose tractor was used in producing 80 acres of corn under the requirements of these regulations. The 80 acres included four 20-acre fields which we felt would give data nearly comparable to average Indiana conditions. Three of these fields were in corn in 1928, giving us an opportunity to deal with stalks directly. No special equipment was used in the work of cleaning up, except shields, wires, and special coulters and jointers on the plow.

The stalks were double-disked crosswise previous to plowing with a 14-inch gang plow.

The plowing, double disking both ways with a harrow behind the disk the second time over, and planting with a four-row checking planter, required 221 hours 30 minutes of field work. Tractor chores, including supplying fuel, oil, and water to the tractor and the greasing of the tractor and implements, required 18 hours 50 minutes, making a total of 240 hours 20 minutes man labor. Fuel consumption amounted to 385.43 gallons of gasoline, and 10.75 gallons of oil were used. With labor at 40 cents per hour, gasoline 13.2 cents per gallon, oil 60 cents per gallon, and an extra man working 20 hours at 30 cents per hour, handling the fertilizer during planting, we had a labor, fuel and oil cost of $159.40, or $1.99 an acre.

Cultivation included going over the fields twice with two two-row, rotary hoes and then cultivating two of the 20-acre fields with a two-row, and the other two fields with a four-row cultivator. The two-row, rigid-frame cultivator was used to cultivate 140 acres, going four times over one field and three times over the other. The four-row cultivator covered 160 acres or four cultivations of each field.

These operations required 142 hours 20 minutes of field work and 6 hours 20 minutes of tractor chores or 148 hours 40 minutes total time for cultivation. This used 220.94 gallons of gasoline and 6 gallons of oil, making a total cost of $96.64, gasoline costing 15.2 cents per gallon. Twenty-five pounds of pressure gun grease costing $3.80, was used up to this time. This gives a labor, fuel, oil and grease cost of $259.84, or $3.25 an acre. Adding to this tractor depreciation at 29.6 cents per hour for 363 5/6 hours ($107.69), a straight 10 per cent on other equipment valued at $801.75 ($80.18), interest at 6 per cent amounting to $45.89 and a repair cost of $5.92, we have a total cost for labor, fuel, oil, grease, interest, depreciation and repairs of $499.52 or $6.24 an acre.

To meet corn borer clean-up regulations the stalks were double-disked crosswise at a cost of $.553 an acre, including tractor depreciation.

Immediately following planting the fields were gone over and all stalks remaining on the surface were hand-picked and burned. This operation required, on the average, 2.42 hours per acre. At 30 cents an hour, the hand-picking cost 73 cents an acre.

Considering the disking of the stalks a part of the clean-up program, although many farmers make this a general practice before plowing, the total cost of the clean-up was $1.28 an acre. Adding this to the production cost of $6.24 an acre, we have $7.52 as the total cost up to harvest time.

You will note that this method of clean-up requires nearly 2½ hours hand labor per acre. For the farmer who has a large corn acreage, this method of control would mean an excessive amount of extra labor at the rush season. The result is an urgent demand upon agricultural engineers to develop ways and means to eliminate this hand labor and enable corn to be produced under control measures with but little extra labor and cost. The European corn borer can be controlled by mechanical means and remarkable strides are being made in the development of labor-saving equipment.

For convenience, let us divide the corn borer territory into two areas: (1) The area where most of the corn is cut, and (2) the area where the corn is husked from the standing stalk or hogged down.

In the first area the problem is comparatively simple. The stationary-knife, low-cutting attachment for corn bind

[1]A contribution to the symposium on "The All-purpose Tractor in Corn Production," presented at the 24th annual meeting of the American Society of Agricultural Engineers, at Moline, Illinois, June 1930.

[2]Agricultural engineer, Purdue University. Assoc. Mem. A.S.A.E.

(Left) Stalks in the field before disking. (Right) Stalks disked down and plowing partly done. The plow shown is a 14-inch, two-bottom gang equipped with trash shields


(Left) First cultivation of young corn with four-row equipment. This corn has previously been gone over twice with a rotary hoe. (Right) The four-row planting equipment used. The man on the tractor in each picture is the author, Mr. Wileman

ers is of prime importance and should prove to be a big factor in corn borer control wherever corn binders are used. This device eliminates the need for extra labor other than treating the harvested stalks in a manner which will destroy the contained corn borers. This inexpensive attachment, costing approximately $10, adds no moving parts to the ordinary corn binder. A stationary convex knife, the shape of which is the key to its successful operation, cuts the corn level with or even slightly below the ground surface. This attachment was developed by federal agricultural engineers and will be available this fall for most makes of corn binders and the field ensilage harvester. During demonstrations held last fall in northeastern Indiana, many farmers remarked that it was well worth the extra cost even where there were no corn borers because of the fine shape in which it left the field.

The eastern part of this stubble territory is normally plowed before seeding to the next crop so that, with the and of large coulters and jointers, wires or other stalk-covering devices and a little care on the part of the plowman, it is not difficult to obtain a quality of work which will give effective corn borer control.

Shredding and ensiling of stalks spells death to the borer and effective cleanup at this point requires only a little more care in adjusting and feeding the machines and cleaning up the leakage carefully when the operation is finished. Either of these methods used in conjunction with a low-cutting corn binder solves the corn borer control problem.

In the territory farther west, where the corn is husked from the standing stalks or is hogged down, greater demands are being made on the agricultural engineer. There the larvae in the whole stalk must be killed in the field.

Clean plowing under of corn stalks is a test for good plowmanship. However, where the stalks are not too heavy some remarkably clean jobs of plowing are being done without any previous treatment of the stalks. In heavy stalks on the heavier types of soils some previous treatment is necessary to secure a clean field without excessive hand picking. Different soil and stalk conditions affect the previous treatment to a considerable extent. Disking; rolling; raking in same direction of plowing without shaving, then burning; and shaving, raking and burning are the common treatments. The shaving, raking and burning naturally gives the best results as a large percentage of the stalks are disposed of previous to plowing. Best coverage results are obtained when large coulters, jointers, and trash wires or similar attachments are used.

A progress report on plow investigations by Wallace Ashby of the U. S. Department of Agriculture, engineering and maintenance division, at Toledo, contains valuable information on plow coverage under widely varying conditions. This work brings out valuable information for the plow manufacturers regarding plow bottom shapes which may materially affect the coverage with the moldboard plow.

We must not overlook the vast acreages of cornstalks which are not plowed but are disked and sown to small grains. To meet this situation we must look to other methods of handing the stalks as this disking practice is here to stay unless an entire reorganization of present farm practices is brought about, which at best would be a long slow procedure. To meet these demands a variety of machines and devices have been or are in the stage of development.

Corn picker-huskers, which are rapidly increasing in numbers, can be equipped with a device for cutting, shredding or otherwise treating stalks as the corn is picked, at a comparatively small extra cost. Several devices of these types are in the experimental stage and when perfected will mean, using the slogan of the combine, "once over and it's all over."

Two-row, sled-type stalk shavers have been developed which level standing stalks and stubble more effectively than the usual poling job. This solves the first step in the raking and burning program, as the severing of the stalks from the ground is essential for good raking. Other types of shavers are in the development stage and may soon be available.

A side-delivery rake especially designed for the raking of cornstalks gives much promise and should make possible a clean raking job. This rake may cost slightly more than the present-day side-delivery rake but will work equally well on hay.

Stalk sweepers for windrowing or collecting stalks for shredding or crushing are also being worked on and show possibilities. After windrowing the quite general practice, in some territories, of burning stalks, if done more carefully, will probably be the corn borer control solution.

In territories where soil and weather conditions make the use of the rotary hoe practical, the drilling of corn rather than check-rowing will probably fit in better with the control problem, as the machines for clean-up work will perform better and with less strain.

Flat cultivation or freedom from ridging when laying the corn by is desirable as it gives a smoother surface over which to operate clean-up machines.

SUMMARY

1. The corn borer can be controlled by mechanical means.

2. The general-purpose tractor lends itself well to use in corn production under corn borer control clean-up practices.

3. Agricultural engineers in close contact with corn borer control work agree that it will not entail the purchase of expensive special equipment, nor will there be an excessive amount of extra labor required.

4. Clean-up practices carried out will mean a better job of farming, and consequently better yields will result from the extra pains necessary to control the corn borer.

Engineering Farm Transportation[1]

By C. M. Eason[2]

WHEN we realize that approximately 600,000,000 pounds of food are eaten every day in the United States alone and that practically none of it is consumed where it is produced—that almost every pound must be transported, by some means or other, distances varying from a few miles to thousands of miles—we begin to get some idea of the part transportation plays in our daily life.

We are accustomed to having anything we want delivered to our homes or factories that we are no more conscious of the part transportation plays in our daily life than we are ordinarily of the blood in our bodies. Yet our present civilization could no more exist without adequate transportation than we could continue to live without proper circulation.

Everyone is more or less familiar with the fact that the proportion of people engaged directly in producing foods and farm products has dropped from 90 per cent to less than 24 per cent in the last century. In a few more decades it seems reasonable to assume that not more than 15 per cent of our population will be engaged in agricultural production. There have been many reasons advanced for this condition; viz: the substitution of animal power for human effort; the substitution of mechanical for hand operations; the use of power-driven for horse-drawn machinery, etc., etc.

Of course, all of these things have had a tremendous bearing on the question but there is one factor (ever present and so utterly obvious that few have noted it when looking for reasons) which is the very foundation of our population shift; i.e., adequate and ever-increasing ability to move food efficiently and quickly from the producer to the consumer.

The construction of railroads during the last half of the nineteenth century was almost solely responsible for the rapid spread of population and the development of natural resources in this country. The use of rail transportation, coming as it did coincident with the development of labor-saving, horse-drawn farm machinery, was responsible for cutting the proportion of agricultural workers from 87 to 38 per cent in a half century. That it was necessary to have an ever-broadening outlet for increased production is obvious, since without the means for reaching ever-expanding markets; i.e., better and cheaper transportation, it would have been utterly impossible to have utilized the increased productivity of our agricultural workers. For example, in the 1890's production did so far exceed demand and transportation facilities that it was cheaper out in Kansas and Nebraska to burn corn for heating homes than to buy coal.

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, Chicago, December 1929.

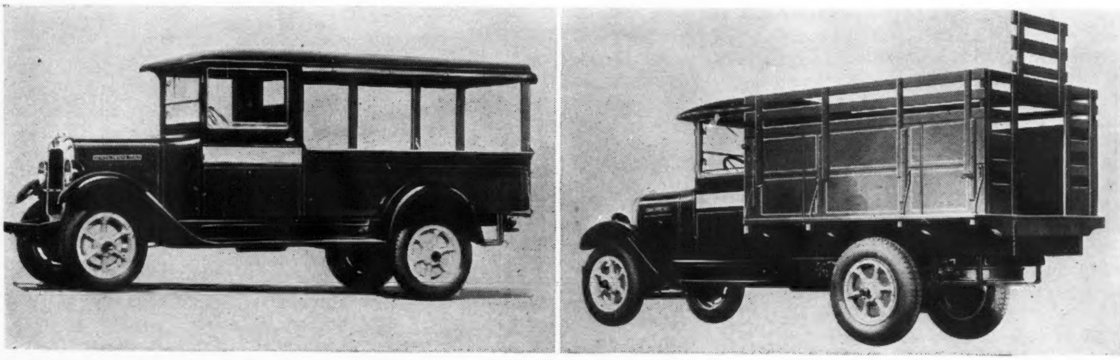
[2]Supervisor of sales engineering, General Motors Truck Company.

Automobiles and Farming. It would seem rather significant that between 1910 and 1920 the proportion of agricultural producers decreased 40 per cent and that this same decade marks the real adoption of the automobile. Back in the horse-and-wagon days, it was common practice for a farmer to spend all day Saturday on a trip to town. As soon as he owned an automobile he could make a trip to town and back in an hour or two, and this had the practical effect of adding an extra working day to the farmer's week. To state it another way, a motor car added at least 20 per cent to a farmer's time for productive labor.

It is very remarkable that up to the present time no one (so far as I have been able to learn) has ever included the farmer-owned motor car in a tabulation of farm power resources. Possibly this is because most people consider the motor car as belonging in the luxury class, but any tool that enables one to do a given amount of work in from 5 to 10 per cent of the time formerly required should surely be classed as a necessity and not a luxury. Allowing only 10 horsepower per car (on the basis that an automobile is ten times faster than a horse), the American farmer now has nearly 50,000,000 horsepower available for transportation. This is equal to or possibly greater than all other forms of primary power; i.e., horses, mules, windmills, electric motors, gas engines, steam engines, gas tractors and trucks now in use on farms.

As of January 1, 1929, there were 24,501,004 motor vehicles registered in the United States. Of this number 5,426,900 (4,729,600 automobiles and 697,300 trucks) were farmer-owned. It is safe to say that 99 out of every 100 farm automobiles are used for the transportation of produce and supplies as well as for taking the family to church and to the movies. Statistics do not disclose the number of homemade, light, two-wheel trailers for hitching on back of the family flivver, but nearly every farmer who owns a motor car has one of these trailers and uses it for loads too bulky or too heavy to carry inside the car. Cans of milk, crates of live chickens, pigs, a cow or a ton of coal can be hauled with these rigs, and the total tonnage moved annually is tremendous.

It takes all day for a horse to make a trip that can be made in an hour or less with a motor car or truck. Consequently, it is not surprising that the total number



(Left) A type of one-ton motor truck with canopy top express body designed for use by market gardeners. (Right) A combination grain and stock rack body on a light 1 to 1½-ton motor truck for light farm use

It may possibly be a good thing for the automobile business that the motoring public is so utterly indifferent to the costs of operating private cars. It is, however, deplorable that contract haulers and truck owners, who must make a living through profitable operation of their trucks, do not pay more attention to operating costs or know more about how to figure them properly.

of horses has steadily decreased during the past few years; i.e., from approximately 22½ million in 1918 to about 14½ million in 1928. The farm tractor has, of course, had a great deal to do with this decrease in horse population, but had it not been for the parallel development of good roads and the use of automobiles, trailers and trucks to do the farm hauling, the decrease in horse population could not possibly have been so startlingly rapid.

The total mileage of surfaced roads is now estimated at ¾ million miles and this is growing at the rate of 50,000 to 60,000 miles per year. It is probable that at least one-third of all the farms in this country are located on hard-surfaced highways, open the year around, and nearly all the rest are on improved dirt or gravel roads which can be used most of the year for automobile and truck travel.

There may be some question as to whether the increased use of the motor car has forced the development of good roads or whether the building of good roads has promoted the increase in the use of motor cars. Regardless, however, of which is the cause and which the effect, the American farmer is surely "automobile conscious."

The following table shows the number and per cent increase for cars, trucks and tractors in use on farms during the past eight years:

	1920	1928	Gain
Automobiles	1,336,046	4,729,600	354 per cent
Trucks	139,169	697,300	401 per cent
Tractors	246,083	781,281	218 per cent

During this period, the total production of passenger cars increased only 163 per cent and trucks 269 per cent, indicating that the rate of gain, for farm-owned motor cars and trucks, is practically double the rate for the country as a whole. When the statistics for 1929 become available they will probably show that there are five passenger cars for every six farms, and that the number of farm-owned motor trucks will practically equal the number of farm tractors, with about one truck or one tractor to every eight farms. The above figures are believed to be relatively correct, although at present there seems to be no absolutely accurate statistical data separating farm-owned cars and trucks from those used in other vocations.

The U. S. Department of Commerce annually publishes a bulletin covering "Manufacture and Sale of Farm Equipment." This is an excellent compilation of data regarding the number and value of practically all items "used either exclusively or to a large extent on farms." This bulletin lists about 500 different products, from plows to wheelbarrows, tractors to neck yokes, combined harvesters to lightning rods, but never a line or a word regarding motor cars or trucks for farms. The automobile and truck manufacturer is probably at fault for this omission, since he probably has never fully realized the vital importance of motor cars and trucks in the development of agriculture.

The motor car industry has, in the National Automobile Chamber of Commerce, the necessary machinery for collecting and compiling statistics regarding the distribution of its products. It would probably be a relatively simple matter to develop records showing the number and value of automobiles and motor trucks sold annually to farmers, and there is no question but that some should be included in the Department of Commerce bulletin along with the information in regard to other farm equipment.

Trucks for Farm Work. It is beyond the scope of this paper to go into detail regarding the practical application of motor trucks to farm hauling since the subject is as extensive and as varied as the types and sizes of farms. In general, the dairy farmer, the fruit grower and the market gardener head the list as regards percentage using trucks. The stock man and small grain farmer come next, and the general farmer last on the list.

Practically every dairy farmer uses trucks for his daily delivery of milk to the nearest creamery station. He either owns and drives the truck himself or hires some contract trucker, operating on a definite route and schedule, to do the hauling. While practically every size and type of truck made will be found in this particular class, the low-priced, so-called one-ton size predominates among those privately owned. The contract hauler will usually have a two to three-ton, heavy-duty, fast, pneumatic-tired truck, although some milk routes are still being worked with the old-style, five-ton, solid-tired vehicles. Most of the larger dairy companies throughout the Middle West are using trucks and trailers quite extensively for bringing milk in to the bottling plants from the outlying pick-up stations. Many of these carry glass-lined, insulated tanks and handle from 2,000 to 3,000 gallons over distances up to 300 miles. The most efficient truck for this service is a high-powered, heavy-duty type equipped with dual pneumatic tires, and the trailers should also have pneumatic tires. Operating speeds of 30 to 40 miles per hour are not uncommon, a run of 300 miles being made in from 10 to 12 hours at night. The retail city delivery of bottle milk is about the only place in the dairy business where horses are used extensively, and even this end of the business is being very rapidly motorized.

The commercial fruit grower finds that the truck enables him to haul his crop from orchard to packing plant more quickly and at lower cost, and long-distance trucking from packing plant to city market is highly developed in some sections of the country. A comparatively high-powered truck, having a carrying capacity of from two to three tons and equipped with dual pneumatic tires is a common size for the big orchardist. A heavy-duty, three to five-ton, high-speed truck, pulling a four-wheel, pneumatic-tired trailer is used for long-distance work. These units operate at speeds and for distances comparable to the long-distance milk hauling.

The market gardener simply cannot operate under present-day conditions without one or more trucks to move his perishable produce to market. He has been forced, by real estate development and high land values, farther and farther from the big cities. The horse and wagon, which was a common sight at any city market a few years ago, is now practically extinct. The market gardener can load his truck in the evening and, if he is not over 50 miles from market, get a full night's sleep, starting out in the morning an hour or two before the market opens. The most common size truck in this service is the 1 and 1½-ton rated capacity, and almost without exception these trucks are scandalously overloaded. They are, of course, fairly high-speed, pneumatic-tired vehicles, and, due to the relatively low mileage and the seasonable nature of the business, the overloading practice is

probably economically justified. Perishable produce is also being brought to the big cities by contract truckers from distances up to 300 miles. These units are the high-speed, pneumatic-tired type and practically all of this work is done over night.

The stock man is also using trucks extensively for shipping his cattle, hogs, chickens, sheep, etc., to packing house or market. Many of the larger operators own their own trucks, but by far the largest percentage of this business is now being done by the trucking contractor who specializes in some particular line and operates usually over more or less fixed routes.

The following figures for 1928 livestock receipts at the Union Stock Yards at Omaha, Nebraska, are very interesting:

	Total receipts (approx.	Total via truck	Per cent trucked
Cattle	1,500,000	262,437	17½ per cent
Hogs	3,200,000	1,204,035	37½ per cent
Sheep	3,000,000	360,000	12 per cent

Practically all the other large packing houses and stock yards in the country show similar percentage of livestock receipts via truck. The number of head trucked in during 1928 was, in most cases, practically double those brought via truck during 1927, and it seems reasonable to assume that within a few years practically all livestock will be delivered to the big packing houses on trucks rather than by rail. The advantage from the shipper's standpoint is the ability the truck gives him to catch the top market with small loads of prime conditioned animals; naturally less shrinkage because of less handling and time in transit; also quicker returns on each shipment. Almost every conceivable kind of equipment is used for transporting livestock from the two-wheel trailer back of an automobile to the largest heavy-duty type of five-ton trucks. However, the most profitable size is undoubtedly the 2 to 3-ton, high-speed, heavy-duty truck with one four-wheel trailer all on pneumatic tires is used largely by the contract hauler who is able to handle about 12 head of cattle or 100 head of hogs or sheep per trip.

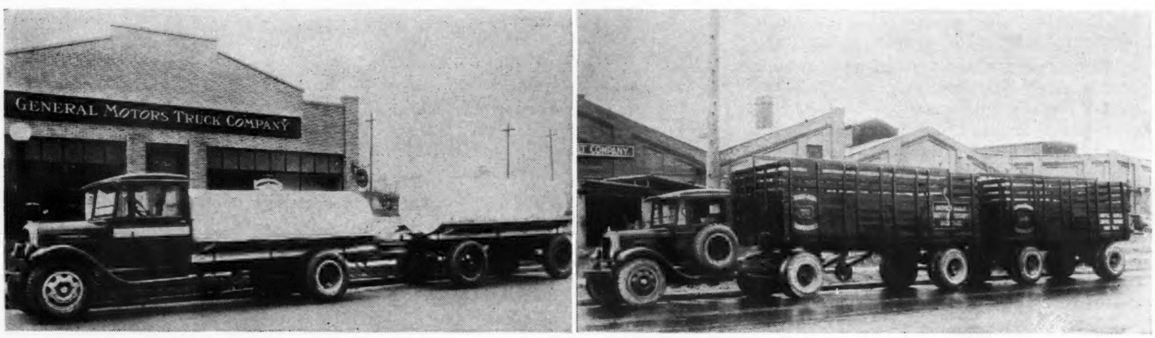
The small grain farmer has been using trucks quite extensively for several years past for hauling his grain to the elevator. There are literally thousands of trucks throughout the wheat belt that are used only during the harvest or threshing season; they stand practically idle along with the rest of the harvesting or threshing equipment during the balance of the year. This, of course, is an expensive and very inefficient way to use a truck, but even so our wheat farmers through the Middle West are finding it more profitable to use trucks than to use horses for this kind of hauling. The rapid increase in the use of the combine in the wheat section is bringing about a very rapid increase in the use of trucks.

The horse and wagon is entirely too slow to keep up the pace set by the combine. A common size unit in this service is the 1 to 1½-ton capacity truck, equipped with a light, inexpensive grain box body, quite similar in general characteristics to the old-fashioned wagon box. As a matter of fact, a lot of wagon boxes have been mounted on trucks for this use. The grain box bodies, ordinarily furnished with light trucks, will carry from 60 to 80 bushels, and it is quite common practice to add an extra set of side boards, bringing the capacity up to 100 to 120 bushels. The payloads therefore vary from 3600 to 7200 pounds when hauling wheat, which is a considerable overload for a light 1 or 1½-ton truck. However, due to the fact that these trucks are used in this manner for only a few days a year, the practice is probably economically sound, although it gives truck manufacturers the shivers to think of overloads of this magnitude. Trucks used in this class of service should be equipped with dual pneumatic tires since they must be taken into the wheat fields to receive their load. Some sort of auxiliary low speed or an exceptionally low gear in the main transmission is also highly desirable in order to make possible handling these overloads on soft ground. Where grain farming is combined with a certain amount of stock raising, the same truck and body equipment can be used for hauling livestock to market.

The average general farmer hasn't gone in quite so strongly for trucks, but it must be borne in mind that he uses the family car instead of the truck, and in many cases the automobile plus a simple, inexpensive two-wheel trailer is probably adequate for his needs. The average farmer will buy a truck some day. A light 1 to 1½-ton capacity truck is practically the only size required. The average farmer will probably first buy a second-hand truck of this variety; usually just short of the junk yard, but for the dozen or so times per year actually needed it will serve the purpose and justify the modest expenditure.

Truck Operating Costs. The farmer is supposed to be notoriously a poor cost keeper, but he couldn't possibly be much worse than the average car owner and certainly no worse than the average trucking contractor. Very few people, owning and driving their own automobile, have any idea nor do they care how much it costs them to run it. In the minds of most people, the cost of gasoline, oil and occasional repairs represents the sum total of their cost of operation, when, as a matter of fact, these items are only a small part of the total.

Several years ago I kept an accurate record of the cost to operate my own car. It was purchased September



(Left) A 4-ton high-speed, heavy-duty motor truck carrying insulated, glass-lined milk tank and pulling a four-wheel trailer carrying a similar tank. The total capacity of this equipment is 2,000 gallons. (Right) A 3 to 5-ton truck-tractor with semi-trailer unit used by contract haulers for livestock, fruit and provisions on long-distance hauling

30, 1922, for a total cash outlay of $2,112.00, including equipment. It was traded in on a new car February 24, 1924, at an allowance of $1,150.00.

The costs of operating this particular car worked out as follows:

Depreciation (17 mos.)	$962.00
Taxes, license, insurance	166.00
Garage rent	315.00
Interest (6% on $2112.00)	179.52
Total fixed charges (17 mos.)	$1622.52
Tires and tire chains	104.40
Gasoline	201.95
Oil, chassis lubrication and alcohol	61.85
Washing and polishing	87.00
Repairs, parts, adjustments, etc.	134.85
Operating expense	590.05
Total cost to run 15,000 miles in 17 months	$2212.57

During the time I owned this car I drove it exactly 15,000 miles, and since the total cost of owning and operating the car for 17 months amounted to $2212.57, my cost was therefore 14.75 cents for every mile driven. After this one experience of keeping accurate records of my personal transportation costs, I lost all interest in further researches in this direction.

It may possibly be a good thing for the automobile business that the motoring public is so utterly indifferent to the costs of operating private cars. It is, however, deplorable that contract haulers and truck owners, who must make a living through profitable operation of their trucks, do not pay more attention to operating costs or know more about how to figure them properly.

The items of cost for operating new motor vehicles may be conveniently grouped under the following main headings:

1. Investment: Made up of the delivered price complete less tires.
2. Fixed Expense: Made up of interest on investment, depreciation, taxes license, insurance, garage, etc.
3. Running Expense: Includes fuel, oil, grease, tires, repairs and maintenance.
4. Payroll Expense: Includes the truck driver and helper's wages, supervision and overhead.

The total cost made up of the above items can then be reduced to cost per day, per mile, per ton, per trip, or any other unit desired.

The accompanying form is one used by the General Motors Truck Company in making up transportation cost estimates, but it may also be used as a guide in setting up the costs for actual operation, since the factors are identical in practically every operating problem.

The proper evaluation of each factor is, however, highly variable. For instance, under "Fixed Expense" the interest on the investment should be based on conditions pertaining locally, and on a constantly depreciating investment is usually figured at one-half the going rate of interest. Taxes and license fees are also highly variable. In some states it is possible to register a 1-ton truck for as little as $10.00, and in other states the fee is practically $100.00. Insurance also is highly variable, depending principally on how complete the coverage may be. Garage rent may or may not be a considerable factor, depending upon location. In a large city this item may amount to as much as $240.00 per year, whereas in a rural community the "shade of the old apple tree" is probably the only expense for this item. The item of depreciation is one which will stand considerable investigation. In a

ESTIMATED TRANSPORTATION COST ANALYSIS

Compiled for................ Date................
Type of Equipment................

	INVESTMENT		
1.	Chassis, F. O. B.	$	
	a. Cab	$	
	b. Body	$	
	c. Painting	$	
	d.	$	
	e.	$	
	f. Freight and Handling	$	
2.	TOTAL INVESTMENT	$	$
3.	Cost of Set of Tires a. .... $		
	b. .... $		
	(Total of item 3— a and b)	$	
4.	Amount to be Depreciated (Item 2, less Items 3)	$	
	FIXED EXPENSE		Cost Per Year
5.	Interest on Total Investment .... % on Item 2		$
6.	Taxes		$
7.	License		$
8.	Insurance (Coverage: $........ Fire and Theft $........ Publ. Liability $........ Property Damage $........ Collision $........ Empl. Liability)		$
9.	Garage		$
10.	Depreciation [illegible]		$
11.			$
12.			$
13.	TOTAL FIXED COST PER YEAR		$
	RUNNING EXPENSE	Cost per Mile	
14.	Fuel........ Miles per Gallon at $........ per Gallon	$	
15.	Tires, $........ for........ Miles Life	$	
16.		$	
17.	Repair and Maintenance, Including Grease	$	
18.		$	
19.	Cylinder oil, ... Miles per Gallon at $........ per Gallon	$	
20.	TOTAL RUNNING EXPENSE PER MILE	$	
21.	Miles Operated per Day		
22.	Days Operated per Year		
23.	Total Miles Operated per Year		
24.	TOTAL RUNNING EXPENSE PER YEAR (Item 20 times Item 23)		$
	PAY ROLL EXPENSE	Cost per Day	
25.	Driver's Wages per (........) Hour, Day	$	
26.	Helper's Wages per (........) Hour, Day	$	
27	Supervision and Overhead Charges	$	
28.	PAY ROLL EXPENSE PER DAY (Total)	$	
29.	TOTAL PAY ROLL EXPENSE PER YEAR (Item 22 times Item 28)		$
30.	TOTAL OPERATING COST PER YEAR (Sum of Items 13, 24, 29)		$
31.	Total Operating Cost per Day (Item 30 divided by Item 22)		$
32.	Total Operating Cost per Mile (Item 30 divided by Item 23)		$
33.	Average Number of Round Trips per Day		
34.	Average Miles per Round Trip		
35.	Average (Units)........ Carried per Round Trip		
36.	Cost per Round Trip. (Item 31 divided by Item 33)		$
37.	Cost per (Unit)........ Carried (Item 36 divided by Item 35)		$
38.	Cost per (Unit)........ Mile		$

truck used constantly for contract hauling, the depreciation may be taken as that percentage of the total investment represented by the number of years of expected life. For trucks or cars used only occasionally, depreciation may be due almost entirely to obsolescence rather than wear of the vehicle.

The factors under "Running Expense" are also equally subject to variation, depending upon road conditions, grades, traffic density, ability of driver, care given for maintenance and speed at which the vehicle is driven. Practical experience with similar trucks operating under similar conditions is about the only safe guide in making up estimates of transportation costs.

In conclusion I should like to say that the question of farm transportation is not basically different from any other vocation; i.e., it is merely the job of moving a given amount of material from point of origin to destination in the most efficient and least expensive possible manner. The American farmer has already gone a long way toward solving the problem because of his experience to date with approximately ¾ million trucks and 5 million motor cars. The question of efficiency has not been of paramount importance; up to the present it has been mostly a question of expediency. To be permanently successful, however, the business must be put on a sound foundation which can only be accomplished by careful analysis of costs balanced against the value of service rendered.

It is quite possible that the contract hauler can render this service at a lower actual cost than would be possible through the individual ownership of motor trucks. There is, however, the intangible value of individual independence, and this factor will have to be weighted quite heavily to justify private ownership of the larger sizes of motor trucks by farmers. Nevertheless, it is our belief that the farm market represents the largest possible potential field for future development of motorized or engineered transportation.

Mechanical Potato Pickers

By A. A. Stone[1] and Eric Patterson[1]

BEFORE many years the job of picking potatoes will be entirely a machine operation. Hand labor has been eliminated in nearly all of the other operations necessary to potato growing, and machines are even now on the market that eliminate the laborious job of hand-picking.

Two types of mechanical potato pickers were used at the New York State Institute of Applied Agriculture at Farmingdale in 1929. These were picking machines only and had no sorting or grading attachment. Each of these machines employs a different principle.

In one the potatoes are carried upward on the picker elevator and emptied into bags at the rear of the elevator. While passing up the elevator men on either side platform must throw off the vines, trash and stones to prevent them from being bagged with the potatoes. The successful operation of this machine requires thorough separation at the digger, so that the load falling on the picker elevator is reasonably clean. For best results, it should be used with a power-driven digger having a seven-foot main elevator, and either the usual vine turner and shaker or an extension elevator in the rear of the main elevator.

The other type, which is shown in the illustration, was used for digging the entire crop on the Institute farm. The trash and vines are carried directly over the rear of the picker elevator and drop to the ground. The potatoes are picked off the long elevator by hand and placed in small conveyors at either side of the main elevator. These side conveyors carry the potatoes backward into bags at either side of the rear platform. Each side conveyor delivers through a two-way chute, permitting four bags to be carried.

The digger elevator delivers its load directly to the main elevator of the picker. No vine turner or extension elevator are used on the digger. It was found that having a man on the digger to throw off the heaviest part of the vines and trash greatly lessened the work of the men on the picker. It will be readily noticed from the illustration that this outfit is long and requires a considerable headland at the ends of the rows for turning. This objection is a valid one and the length of the outfit must be reduced as much as possible. However, for these trials the fields were laid out in lands, and it was worked out so that wide, easy turns could always be made. With the type of tractor used, it might be well to eliminate the forecarriage and couple the digger directly to the tractor drawbar, thus shortening the outfit and making turning easier. When lighter tractors are used, however, there is some question as to the advisability of doing this. Reports from several sources indicate that the added weight of the digger, when hung directly from the tractor drawbar, causes the tractor wheels to slip and dig in.

No attempt was made to keep accurate figures showing the labor or time-saving value of the machine, as the chief interest was in testing it from a mechanical standpoint. Various observers agreed, however, that it reduced the time usually required from 30 to 50 per cent. The use of the picker made continuous digging possible, whereas with hand-picking methods the digging proceeds so much faster than the picking that the digger is kept idle much of the time waiting for the pickers to catch up. Digging proceeded at the rate of about two hours per acre.

There was indication that some potatoes were bruised in passing over the picker. It was difficult to determine just where this bruising occurred, but it seemed to be on the main elevator of the picker, as occasionally potatoes passing up this elevator would be jostled due to uneven ground and would roll down the elevator striking at the bottom with sufficient force to cause the bruising. It was also noted that quite a number of small potatoes were left on the ground. These were believed to have sifted through the links of the picker elevator, but upon further examination it was discovered that many of them were passing through the links of the digger elevator. This was not considered a serious fault as many growers prefer to leave such small potatoes in the field.

About five acres of Green Mountains and five acres of Cobblers were harvested. Digging conditions were ideal. The crops were light, yielding about 100 bushels per acre. Vines and surface growth were also light and the dry soil sifted through the digger elevator quickly, leaving a fairly clean load to be delivered to the picker elevator. Under the conditions existing this year, the crew shown was sufficient, but in an ordinary year two additional men would be needed, one more on each side of the picker.

A tractor with a slow forward speed is necessary. First or low speed was found to give the best results. It was necessary to idle down the tractor motor considerably in order to reduce the forward speed sufficiently. Where a traction type of digger is used, this reduction in forward speed would in ordinary years cause poor separation at the digger, but this year it made little difference. Probably an engine driven or a power take-off-driven digger would be better than a traction digger for use with a potato picker.

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[2]Farm superintendent, New York State Institute of Applied Agriculture.

Potato combine outfit used at the State Institute of Applied Agriculture, at Farmingdale, L. I., N. Y., for digging, picking and bagging potatoes

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Common Storage of Vegetables: A Discussion of the Factors Involved.—Sundried Vegetables (Oklahoma Sta. Circ. 75 (1929), pp. 8).—The first part of this circular consists of a general discussion, by M. Benoy, of the changes taking place in vegetables on storage and the requirements which must be made for satisfactory storage, with a summary of temperature and humidity conditions for successful storage of different vegetables. The prospects for common storage of vegetables in Oklahoma are considered poor unless properly insulated cellars are used.

As a substitute for storage sundrying is suggested and the second part of the circular consists of the report, by Benoy and G. Steininger, of experiments conducted to determine what vegetables may be dried satisfactorily under Oklahoma conditions. The vegetables tested included corn, carrots, tomatoes, onions, cabbage, pimentos, green peppers, beets, beet leaves, okra, and potatoes. Some of these were parboiled or blanched before drying and others simply cut in thin slices. All were dried in homemade racks placed outside the laboratory windows, three days being allowed for drying. The dried materials were stored in a dark closet for at least six months and then cooked after varying periods of soaking in water. Of the different vegetables tested, okra gave in all respects the most satisfactory dried product, with beets ranking second and onions and beet greens coming next.

The study, while not exhaustive, is considered to demonstrate that certain vegetables can be preserved satisfactorily in Oklahoma by sundrying.

Factors Affecting the Cost of Tractor Logging in the California Pine Region, M. E. Krueger (California Sta. Bul. 474 (1929), pp. 44, figs. 11).—Continuing the series of bulletins on cost studies, data are presented on costs of tractor yarding in three different forest areas in the Sierra region. The tractors used in the several operations were all of the 60 horsepower tracklaying type, and the predominant log length was 32 feet. Two methods of using tractors were studied, namely, ground skidding and yarding with Robinson big wheels.

As in the case of steam donkey yarding, other factors being equal, small diameter logs cost more to yard by ground skidding than did large diameter logs, chiefly owing to the difficulty in maintaining a high average load per trip. However, the difference was not as great as in the case of donkey yarding. The cost per 1,000 board feet increased very rapidly below 20 inches in diameter, making it advisable not to cut below 10 to 12-inch diameters. The size of the load was the biggest factor affecting the cost of yarding. Below 800 board feet the cost per 1,000 board feet increased very rapidly. Data suggested that 2,400 board feet was a practical maximum load for skidding. Slope was found an important factor in determining skidding costs, those of from 10 to 30 per cent being ideal, with 50 per cent as a practical maximum. Profitable yarding distances were found to be closely related to railroad costs, with greater possibility of excessive costs from yarding short of the economic maximum rather than beyond.

Concerning the use of hydraulic big wheels, bunching costs were found to be a very large factor in yarding operations, the actual cost of bunching being usually in direct proportion to the number of pieces handled per bunch. Summing up, the author states that the main requisite for successful tractor logging is proper organization to see that there is adequate equipment with which to maintain high average loads per trip.

The Influence of the Combine on Agronomic Practices and Research, J. H. Martin, (Journal of American Society of Agronomy, 21 (1929), No. 7, pp. 766-773).—Cooperative investigations of combine harvesting by the U. S. Department of Agriculture and 13 state experiment stations during 3 years and observations elsewhere have shown how the combine has affected current agronomic practice and indicated its probable influence on future practice, especially in regard to type of farming, size of farm, tillage, double cropping, organic matter, the use of straw for feed, crop losses, crop varieties, moisture content of grain, weeds, and the culture of marginal lands. Agronomic problems concerning cropping systems, rotations, soil fertility, crop residues, and crop varieties which have arisen since the combine has come into general use are suggested for investigation.

Poultry Experiments at the New Jersey Stations (New Jersey Station Report, 1928, pp. 12-15.)—The results of three experiments are noted.

A study of the value of the glass substitute, Cel-O-Glass, as a medium for the passage of physiologically active ultra-violet radiations. Chicks exposed to direct sunlight for an average of 4.5 minutes daily were found by O. N. Massengale and C. H. Howard to have as much ash in their bones as chicks exposed for 15 minutes to ultra-violet light. About three times as much radiation is required by chicks when ultra-violet light is filtered through a glass substitute as when the chicks are exposed to the direct rays of the sun.

A single exposure of 45 minutes to the rays of a quartz mercury lamp was effective for 1 week for preventing leg weakness in chicks, while 90 minutes' exposure was effective for 2 weeks. Longer exposures did not prolong the effect. Cel-O-Glass that had been exposed to the weather for 1 year was still effective for transmitting the ultra-violet light of winter sunshine. Chicks raised to 8 weeks of age on a leg weakness-producing ration in a house the entire front of which was made of Cel-O-Glass showed no signs of leg weakness, and the bone formation was normal.

Ergosterol exposed to the 3,130 angstrom wave length was effective for curing rickets, although not as effective as that exposed to the 3,025 angstrom wave length. These results are significant since the intensity of the 3,130 angstrom wave length of winter sunlight is not diminished as much as the 3,025 angstrom wave length.

Economic Aspects of Local Elevator Organization, H. Metzger and H. B. Price (Minnesota Station Bulletin 251 (1929), pp. 55, figs. 15).—This bulletin reports the results of a survey made in the winter of 1925 in cooperation with the Bureau of Agricultural Economics, U. S. D. A., of 49 local farmers' elevators handling from 25,000 to 703,000 bu. of grain per year. The organization and costs of labor and management, building and site, equipment, and other costs are analyzed and the elements affecting cost are discussed.

The cost of handling grain by the different elevators varied from 1 to 12 cents per bushel, averaging 5 cents. More than 80 per cent of the elevators had costs ranging from 2 to 9 cents per bushel. Of the average total costs, labor and management comprised 46 per cent, sideline rental and buildings 20, equipment 12, electricity and gasoline 4, interest on grain 5, insurance on grain 3, taxes on grain 1, and miscellaneous costs 9 per cent. Tables and graphs are included showing the relation between volume of business and the various elementary costs noted above and the combined costs per bushel and the costs of handling different volumes of different grains.

The important factors affecting efficient management as shown by the analysis were as follows: Volume of business was the most important factor in cost. Elevator marketing less than 125,000 bushels of grain had substantially higher costs than those marketing larger volumes. Labor and management was the second factor in importance. The amount of labor used is much more important than the rate paid. Elevators marketing less than 100,000 bushels and doing an ordinary sideline business can not afford more than one regular man. Adjustment of the size and cost of equipment to the probable volume of business is important. Consideration should be given to shifts in type of farming under way in planning buildings. Sidelines increase volume of business and efficiency when properly merchandised. Ability of managers to keep records is an asset to the enterprise.

Ultra-Violet Wave Lengths Valuable in the Cure of Rickets in Chickens, G. H. Maughan (American Journal of Physiology, 87 (1928), No. 2, pp. 381-398, figs. 4).—By using glass filters capable of absorbing different quantities of the shorter ultra-violet light, the author treated 10 groups of approximately 10 rachitic chicks each with varying wave lengths. It was found that the range of effectiveness in curing rickets lay between 3,130 and 2,650 a. u. Below 2,896 a. u. the light was relatively weak in its curative effect, and the 3,130 a. u. length apparently had no beneficial effect. The results showed rather conclusively that wave lengths 2,968 a. u. were the most potent, and that wave lengths 3,024 a. u. were about one-fourth as effective in the cure of rickets.

Appended is a discussion by C. V. Shapiro of the method of determining the transmissive power of the glass filters used in this work.

The Importance of Dry Milk Cans, H. H. Sommer and B. W. Sarles (Milk Dealer, 18 (1929), No. 11, pp. 60, 61, 96).—The condition of milk cans as they leave the washing machine as a possible source of bacterial contamination of milk was the object of this study at the Wisconsin Experiment Station. Cans washed in three different makes of can washers were studied. After the can came from the washer, samples for bacterial counts were obtained by placing 1 liter of sterile water in the can, putting the lid on tight, and shaking the can vigorously in a horizontal position. A sample of water was then drawn from the can, plated on suitable position, incubated for 48 hours, and the number of bacteria in the can computed. Additional samples were taken from cans after they had stood for 24 or 48 hours at room temperature with the lids on.

The cans from the first washer were clean and hot on leaving the machine, but were quite wet when they had cooled, due mainly to steam and hot, moist air left in the can. It was estimated that immediately after washing 20 cans contained on an average enough bacteria per can to raise the count of milk only 1.5 bacteria per cubic centimeter. However, after standing 24 hours 33 new cans from this washer had enough bacteria to raise the count of milk 13,360 per cubic centimeter, and 42 old cans 40,813 per cubic centimeter. The cans from the second washer were very clean, hot, and dry on leaving the washer, and 7 cans contained only enough bacteria to raise the count of milk less than one organism per cubic centimeter. Even after 38 cans had stood for 24 hours the bacteria had increased only to a point where the bacterial count of milk was raised 17 bacteria per cubic centimeter. The cans came from the third washer in much the same condtion as from the first. An average of 12 cans tightly closed and examined after 48 hours showed bacteria equivalent to a milk contamination of 8,691 bacteria per cubic centimeter.

These results show the importance of dry cans for reducing bacterial contamination.

Human Energy Cost of Operating a Vacuum Clearner at Different Speeds, V. Swartz (Journal of Home Economics, 21 (1929), No. 6, pp. 439-446).—This investigation, conducted in the laboratories of a vacuum cleaner company, was undertaken to determine the energy cost of operating a vacuum cleaner and the most efficient speed of operation. An intensive series of experiments was first conducted on one subject, the author, and this was followed by a confirmatory series with nine other subjects, most of them women graduate students of the University of Chicago. The speeds studied were 0.5, 1, 2, 3, and 4 feet per second, the cleaner being operated on a 9 by 12 foot Karnak Wilton rug. The determinations were made by indirect calorimetry, using a Douglas bag. Each experiment proper was preceded by a preliminary work period of the same length. For purposes of comparison, metabolic determinations were conducted on the same subjects at rest and walking without the apparatus. In all 150 experiments were performed.

With all the subjects the resting values fell below the basal values predicted by the DuBois standards, ranging from —0.8 to —16.4 per cent. The total energy cost of operating the cleaner increased with increased speed, from 55.5 calories per square meter per hour at 0.5 feet and 59.1 at 1 foot per second to 146.3 at 4 feet. The net costs, representing the difference between total expenditure and expenditure for standing and walking, were low at the moderate speeds, being 7.4 calories at 0.5 feet and 11 at 1 foot per second. The net cost per unit of rug coverage was higher at both the very low speeds and the very fast ones, being 7.4 calories per square meter per hour at the 0.5-foot rate, 5.5 at the 1-foot rate, and 12.3 at the 4-foot rate.

It was concluded that on the basis of efficient cleaning, 0.5 or 1 foot per second is the most economical of human energy.

Financial Settlements of Defaulting Irrigation Enterprises, W. A. Hutchins, (U. S. Department of Agriculture Circular 72 (1929), pp. 46).—This bulletin presents the results of a study of debt settlements of 37 irrigation projects which have defaulted on obligations and of a number of other projects on which settlement plans have not been put into effect. The causes of default, correction of such causes, character of obligations, parties to debt settlements, character of settlements from creditors' and landowners' standpoints, points involved in refinancing plans, and the methods of protecting paying landowners are discussed.

Brief summaries are included of the essential details of 13 typical settlements.

Physiological Shrinkage of Potatoes in Storage, C. O. Appleman, W. D. Kimbrough, and C. L. Smith (Maryland Station Bulletin 303 (1928), pp. 159-175, figs 4).—The experiments recorded dealt with the variation in the rate of physiological shrinkage of potatoes because of structural and physiological changes in the tubers during different periods in their storage life. The actual loss in weight of potatoes on account of respiration was very small compared with the loss in weight due to evaporation of water, even at the fairly high temperature at which respiration tests were made. Physiological shrinkage was considered entirely as to water loss, although it included the slight shrinkage by respiration. The rate of water loss was compared for selected lots of potatoes at intervals with the current rate of evaporation from porous clay atmometers. Any deviation of these ratios from a constant was considered due to internal changes affecting the transpiration rate of the tubers. The principal observations in these studies have been noted earlier (E. S. R., 60, p. 330).

The higher shrinkage rate of immature potatoes during early storage declined rapidly, and by midstorage practically no difference existed between the shrinkage rates of immature and mature tubers, even under widely varying conditions. At very low temperatures immature potatoes lost water at a faster rate for a longer period, probably because of delayed cork formation at low temperature. Potatoes apparently fully mature when dug lost water, especially during early storage, more rapidly at very low temperatures than at higher temperatures, even though the saturation deficits were greater at the higher temperatures. The actual shrinkage rates of potatoes kept under constant temperature and humidity conditions showed the same general trend as that indicated by the transpiration-evaporation ratios.

The Durability of a Glass Substitute, W. C. Russell and C. H. Howard (Poultry Science, 8 (1929), No. 5, pp. 290-297, figs. 2).—A biological analysis to determine whether 13.5 months of continuous exposure to weather conditions had decreased the efficiency of a glass substitute, Cel-O-Glass, was conducted at the New Jersey Experiment Stations, using three lots of 100 7-day-old White Leghorn chicks each. One lot was confinded in a house in which the south wall was made of New Cel-O-Glass, the second lot in a house in which the south wall was made of 13.5-months-old Cel-O-Glass, while the third lot was kept as a control group out of contact with direct sunlight. Ash determinations were made at weekly intervals from February 15 to April 17 of the pooled femurs and humeri of 10 individuals from lots 1 and 2, and four times during the experiment from lot 3.

The Cel-O-Glass used in lot 2 transmitted enough ultraviolet light to produce the same bone formation as did the same material when new. No case of leg weakness or malformation of bones occurred in either lot. At a later date spectrographic measurements showed a decrease in the percentage transmission with weathering, but in this case the decrease was not sufficient to cause any difference in the bone formation.

Low-Temperature Injury to Stored Sugar Cane, G. B. Sabtoris (Journal of Agricultural Research [U. S.], 38 (1929), No. 4, pp. 195-203).—The results are given of a study of the effect of low-temperature storage on the germination of sugarcane. It was found that the best temperature for the storage of sugarcane is from 8 to 10 degrees (Centrigrade), and the cane should be packed in some material that will maintain its moisture content.

The cold storage of sugarcane seed as a regular plantation practice is not considered practicable. At a continuous temperature of 3 degrees the seed cane was found to be injured to such an extent that it would not germinate. Most of the fungi that caused damage to seed cane were found to grow well at 12 degrees and some of them at 7 degrees. At a temperature as low as 6 degrees there was development of the roots and buds of the sugarcane. The freezing point of the juice of sugarcane is said to be about —1 degrees. Seed cuttings of Louisiana Purple did not germinate after exposure to a temperature of from —2 to —5 degrees for more than 80 minutes. On the other hand, the cuttings of P. O. J. 213 germinated after exposure to a temperature of —1.5 degrees for 105 minutes.

Forced Ventilation of Tomato Plant Beds (Indiana Station Report 1928, pp. 52, 53).—It is stated that in an experimental bed tomato plants inoculated with Cladosporium and Septoria did not develop these diseases when the foliage was kept dry by the circulation of warm air with an electric fan. Dusting the beds with copper dust at weekly intervals also proved effective as a control measure.

The Utilization of Moisture on Heavy Soils of the Southern Great Plains, H. H. Finnell (Oklahoma Station Bulletin 190 (1929), pp. 24).—From among a large variety of observations on Amarillo silty clay loam during the crop season 1924-1927 and conclusions recorded the following may be cited:

From 22 to 39 per cent of the total rainfall of a wet period might go into the subsoil, and in the heavy type of plains soil investigated about 20 per cent of the annual rainfall became subsoil moisture. Showers in which the precipitation amounted to 0.5 inches or less did not increase the soil moisture unless these light rains fell during consecutive days; and rains exceeding 1 inch occasioned some run-off unless they fell very slowly or were held on the field by contour tillage or by level

terraces. Run-off from heavy soils of "minimum slope" was estimated at 13.5 per cent of the total rainfall.

About 20.7 per cent of the total rainfall was found to become soil moisture. Of this, some 2.7 per cent was lost in the evaporation occasioned by ordinary tillage operations, leaving 18 per cent available to plants. About 65.8 per cent of the total rainfall was found to evaporate from the surface either during the precipitation or immediately thereafter; and out of the portion so lost 31.3 per cent is considered to have been contributed by showers individually too light to add anything to the "permanent store" of soil moisture. The fractions of the rainfall which were found so light or so heavy as to add nothing to the soil moisture did, none the less, aid materially in crop growth.

Under the conditions of the cropping experiments, the average growing season having been 114 days, an average of 0.91 inches of water in addition to the current rainfall was taken from the soil by the crop. With respect to crop yield, the initial soil moisture content was found to have an effect approximately equal to that of the quantity of the current rainfall.

Only such cultural conditions as remove moisture very rapidly, deep plowing, for example, or plant growth, were found to threaten the immediate loss of a body of stored moisture. The temperature appeared to have an effect relatively unimportant with respect to the quantity of moisture stored or to the rate of gain of moisture in the soil, but was highly significant in modifying the relationships of rainfall, wind, and humidity to the behavior of soil moisture.

Permeability of Soils (New Mexico Station Report 1928, pp. 14, 15).—Continuing previous work (E. S. R., 57, p. 315), laboratory tests of a number of substances are reported as having brought about a much improved permeability and tilth. Difficulty was encountered, however, in securing sufficiently thorough mixing of the amendment with the soil in the field tests. In fact "it appears impossible to mix the amendment intimately and uniformly with the soil to any desired depth, and this must be done if the maximum of improvement is [to be] obtained." Progress of a study of the practicability of mixing the amendment with the soil by methods of cultivation normally required in the growing of the crop is noted. Analyses indicate that the soils so far tested "are in worse condition than they were 5 years ago. The lack of cultivation during the years when this land was in alfalfa undoubtedly tended to increase the hardness, the impermeability, and the alkali content. On the other hand, the cultivation given in the growing of one crop of cotton did not very appreciably improve these properties of the soil."

The Cost of Handling Fluid Milk and Cream in Country Plants, C. K. Tucker (New York Cornell Station Bulletin 473 (1929), pp. 119, figs. 11).—This bulletin reports the results of a study to determine the costs of handling fluid milk and cream in country plants and the effects of various factors upon the efficiency of operation. It is based upon records and data regarding operating costs, volume of product, distribution of labor, and other information obtained for the fiscal years ended, for the different firms, from March 31 to December 31, 1925, and from 38 plants selling raw milk in 40-quart cans, 18 plants selling pasteurized milk in 40-quart cans, 15 plants selling pasteurized milk in bottles, and 10 plants selling cream in 40-quart cans.

Tables are given and discussed showing for each type of plant (1) the elementary costs—land and buildings, equipment, management and labor, supplies, and miscellaneous costs; (2) the different intermediate costs—steam generation, ice-machine operation, water supply, and general cleaning; and (3) the distribution of the elementary and immediate costs to the various operations. Tables are also included with explanatory text showing the annual operating costs in a milk plant making Cheddar cheese and one making heavy cream, condensed milk, and by-products.

The average annual costs of operating the 81 plants were for raw milk plants $16,164.11, pasteurizing plants $17,239.91, bottling plants $68,746.66, and cream plants $51,316.86, being 22.9 cents, 32.8, 61.3, and 161.7 cents, respectively, per 100 pounds of milk. The volume of milk handled, investment in plant and equipment, arrangement of plant, seasonal receipts of milk, and method of refrigeration were factors affecting the cost per 100 pounds of milk, the volume of milk received being the most important factor. Land, building, and equipment costs constituted from 24.4 to 31.8 per cent of the total costs of operation and were not much greater in the plants handling a large volume of milk than in those handling a small volume. Variations in receipts of milk at different reasons increased the costs of operation. The use of natural ice was found to be more economical than mechanical refrigeration in plants the annual receipts of which were less than 8,000,000 pounds of milk. The purchase of water from public supplies was generally cheaper than pumping. Cooling was the most expensive operation in the raw milk, pasteurizing, and cream plants, and bottling in the bottling plants.

Sterilization of Dairy Utensils with Humidified Hot Air, A. W. Farrall and W. M. Regan (California Station Bulletin 468 (1929), pp. 13, figs. 4).—In an effort to determine the value of humidified hot air for sterilizing dairy utensils, its operation was compared with that of two other types of known efficiency, namely, the steam boiler and the steam electric methods. A galvanized iron tank, connected with a steam boiler and fitted with a sump in which immersion type electric heaters or electric air heaters could be placed, was used for all three methods. The time and temperature relationships inside the tank, the power and energy requirements, bactericidal efficiency, moisture remaining on apparatus and utensils after sterilization, and the practicability of operation were measured in a series of tests of each of the three methods.

A temperature of 210 degrees (Fahrenheit) was reached in 54 minutes with the humidified hot air method, using a 9.58 kilowatt heater; in 51 minutes with the steam electric method, using a 16.24 kilowatt steam electric type heater; and in 76.5 minutes with the steam boiler, including the time necessary to generate 80 pounds of steam. There were slight variations in temperature with the humidified hot air, while the sterilizer was heating up. This method was the most economical in cost of energy for operation, and the steam electric method was the most expensive. The humidified hot air method left the utensils practically dry, while an appreciable amount of water was left on them when steam was used. The bacterial reduction was quite satisfactory with the hot air method. In practice this method proved a satisfactory and efficient means of sterilizing dairy utensils. The chief disadvantage of the method is that it furnishes no hot water for washing utensils.

The Combination Cleaning and Treating of Seed Wheat, F. C. Meier, E. G. Boerner, G. P. Bodnar, C. E. Leighty, and J. E. Coke (U. S. Department of Agriculture Leaflet 33 (1929), pp. 8, figs. 4).—The merits of removing weed seeds and treating seed wheat for stinking smut in a combined operation are described briefly, with an account by Coke of the organization and operation of a community grain-cleaning and treating machine.

Book Review

"Handbook of Culvert and Drainage Practice" is published by the Armco Culvert Manufacturers Association to fill the need for a volume giving the engineer data on research, design and the solution of practical problems for all phases of drainage. It should be useful to engineering students as well as to engineers in public and private practice. Section headings are Drainage Requirements, Research, Design, Special Design Problems, Subsurface Drainage, Municipal and Subdivision Drainage, Land Reclamation, Field Instructions, and General Tables. As the printing is on a good grade of light paper the book is only one-half inch thick, although it contains 350 pages. It is available from the Association at Middletown, Ohio, at $2.00 per copy.

"The English Plough," by J. B. Passmore, lecturer in agricultural machinery at the University of Reading, is an historical and mechanical study of the subject from its pre-Saxon origin down through the nineteenth century. The four sections of the text are subtitled "The Development of the English Plough," "Descriptions of Ploughs," "The Construction of Ploughs" and "One-Way Ploughs." An index and bibliography are included. Oxford University Press, 114 Fifth Ave., New York, New York, price the book in America at $2.50 per copy.

"Organization and Reports" of the International Congress of Agricultural Engineering have been published by the Congress in a 500-page, paper-bound book. The published contributions of American agricultural engineers include "Tests of Agricultural Machines," by H. E. Murdock; "Progress in Artifical Dehydration of Forage Crops in the United States," by H. B. Josephson; "Artificial Dehydration of Forage Crops in the United States," by Harold T. Barr; "The Refrigeration of Milk on Dairy Farms," by W. C. Harrington; "Interruptions Proportional to the Area Worked and High Capacity Field Machines," by E. G. McKibben; "Spraying Fruit Trees from Stationary Plants," by E. R. Gross; "Engine Crankcase Oil Filters for Automotive Vehicles and What they Remove from the Oil," by A. H. Hoffman; "Methods of Testing the Efficiency and Restriction of Air Cleaners for the Carburetors of Internal Combustion Engines," by A. H. Hoffman; and "Electricity on the Farm in Idaho," by Hobart Beresford. Only the papers of the English-speaking contributors are printed in English. No statement is given as to the price and availability of the book, but inquiries may be directed to the Congress at Gembloux, Belgium.

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Henry Giese

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AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

Another Early Reference

Editor AGRICULTURAL ENGINEERING:

I THOUGHT you might be interested in another reference which I found recently to the early use of the term "agricultural engineer." In looking over an old report of the U. S. Department of Agriculture for 1866 (Isaac Newton, commissioner), I found it on page 234 of the report, and the following paragraph, including the heading, will be of particular interest and significance to agricultural engineers:

AGRICULTURAL ENGINEERS

"What wonders have been wrought in farm implements in the brief space of forty years! The young men of our country cannot appreciate the great contrast between a complete set of farm implements forty years ago and the hand tools, implements and machinery required at the present day to constitute a full set of implements. Forty years ago a farmer could carry all the tools required on a farm of ordinary size, in an ox-cart, at one load; but today the tools and machinery on that same farm cannot be transported in six ox-carts. Let us, for a moment, direct our attention to the implements for gathering a crop of grain, and preparing it for market. Then, a cradle worth $2.50, and a rake worth twenty-five cents, a flail fifty cents, and a fan for cleaning the grain worth $1.00, was about all that was required; but today the mower and reaper and the threshing machine must be brought into requisition. Almost every operation must be performed by efficient and complex machinery, requiring years of practical experience to manage with skill and efficiency. Almost every operation is performed on the farm by some kind of implement, which requires more wisdom, judgment, and discretion to put it in order and to keep it from getting out of order, than an engineer exercises in running a steam engine.

"We are a nation of scientific inventors. Every week or every month developments in labor-saving machinery are given to the world that astonish everybody. . . . . As men become familiar with the laws of matter, and acquaint themselves with philosophical and mechanical principles, they discover how easy it is to make an application of their knowledge in improving some of the implements of agriculture."

F. D. CORNELL, JR.

EDITOR'S NOTE: Mayhap our grandsons, 75 years hence, will read our present-day treatises on the advancement in agricultural engineering with the same sort of a smile as we today read the foregoing. But we hope they will give us due credit for the progress we have made over what our grandfathers knew.

Plant Patents and Large-Scale Farming

THE full significance of the granting of patents on plants, authorized by the last Congress, can scarcely be foreseen at this time, but there is every reason to believe that this extension of our patent system will effect a corresponding extension of its benefits.

While the patent privilege has not made invention a royal road to riches, the continually growing business of the Patent Office has amply proven that people appreciate being given a sporting chance to profit by their originality. They will not be long in taking advantage of their new opportunities.

There are many reasons to believe that the patenting of plants will give further encouragement to the generally increasing scale of farm operations. High fixed overhead is always one inducement to large-scale operation and mass production. High production is necessary to bring the unit cost of a high overhead within practicable limits. The increasing investment in equipment necessary to follow the most efficient production practices, together with rising standards and costs of living, have no doubt been a factor in the trend of the past several years toward larger farms.

Farming with patented plants will add some new factors to fixed overhead. The cost of development, patenting, and any infringement lawsuits should be amortized within the period of patent protection. As some patented plants will no doubt be rendered commercially obsolete by the subsequent patenting and production of superior plants an allowance for obsolescence should probably be computed in fixed overhead. In the case of plants requiring special production or farm processing machinery its cost will be an additional item in overhead. Of course it is possible that some plants will be developed which will require less production machinery, but the trend is not in that direction.

Particularly in the case of tree crops, which require a number of years to mature and come into bearing, there will be a tendency for the inventor and his licenses to get the jump on competition by getting established on a large scale before expiration of the patent.

Perhaps the most potent factor in business expansion is success. Where a business is producing a satisfactory return on the investment, it is obvious that its owners will have both the means and the inclination to turn some of the profits back into the business for purposes of expansion. To the extent that a particular plant is a commercial success its legally protected growers will rapidly acquire the necessary capital and will need no further inducement to expand operations.

Considering the biological, chemical, mechanical, legal and financial complications involved, it seems probable that the growing of anything patented, from apples to zymogenes, will be a business distinct from farming as it is practiced today. It will require increased capital; a working organization or the consulting services of many specialists capable of an understanding cooperation toward each other and the business as a whole; and a management which ranks high in coordinating ability, vision and pioneering spirit.

Patent protection for new plants may also encourage agricultural engineering research, particularly in two directions. We have in mind, for one thing, cooperation of rural electrification men with biologists in giving further study to the effect of ultra-violet ray treatments on plant heredity. The other is study of and possible improvement in the efficiency of plants as converters of solar energy and the materials of nature into forms more useful to man. C. F. Kettering pointed out the importance of such research from a scientific standpoint in addressing the 24th annual meeting of American Society of Agricultural Engineers[1]. The plant patent law adds the profit motive.

[1]"Some Fundamentals of Engineering Research" by C. F. Kettering, AGRICULTURAL ENGINEERING, August, 1930 (p. 263).

A. S. A. E. and Related Activities

International Congress of Agricultural Engineering Held

PRESIDENT G. Bouckaert of the International Congress of Agricultural Engineering Called the assembly to order at Liege, Belgium, on August 3. Delegates from more than twenty countries were present. In his opening address the President outlined the need of a permanent international body to deal with agricultural engineering problems. This matter was taken up again at a later session.

Technical papers and reports scheduled were presented in summary in four simultaneous sessions under the titles "Agricultural Machinery," "Scientific Organization of Work," "Motor Tillage," and "Electricity." A book (reviewed elsewhere in this issue) on the organization and reports of the Congress has been published.

H. B. Josephson, official delegate of the American Society of Agricultural Engineers, was present and presented before the session on agricultural machinery a summary of his paper on "Progress in Artifical Dehydration of Forage Crops in the United States."

E. R. Gross, professor of agricultural engineering, Rutgers University, and W. C. Harrington, agricultural engineer, Portland Cement Association, also attended the Congress and made their contributions in person. American agricultural engineers who contributed papers but who were not present at the Congress include H. E. Murdock, H. T. Barr, E. G. McKibben, A. H. Hoffman and Hobart Beresford.

At a general session of the Congress devoted to the organization of an International Commission of Agricultural Engineering it was decided that it should be the function of such commission to act as a clearing house of information on agricultural engineering research, to stimulate it and to obviate unnecessary duplication. According to preliminary plans each country represented would designate four members, one representing each of four major branches of agricultural engineering.

Delegates to the Congress were presented to the Belgian Minister of Agriculture, visited the state agricultural college at Gembloux, and were shown through the works of farm machinery manufacturers there.

Details of North Atlantic Section Meeting Announced

THE North Atlantic Section of the American Society of Agricultural Engineers will hold its sixth meeting in Rochester, New York, October 16, 17 and 18. Headquarters for the Section during the three-day gathering will be the Seneca Hotel.

B. B. Robb, chairman of the program committee, and L. S. Caple, chairman of the committee on local arrangements, are taking steps to see that this meeting eclipses all previous meetings of the Section. Entertainment for ladies is in charge of Miss Helen A. Smith.

Rochester attractions include a noted city park system, highly modernized educational facilities, the Eastman theater, large nurseries and numerous manufacturing plants, many of which lead the world in their particular lines.

The tentative program for the meeting follows:

Forenoon Session—Thursday, October 16

Address of the Chairman—R. W. Carpenter, agricultural engineer, University of Maryland.

"Electric Hotbeds"—Maurice Nixon, Cornell University

"Present Status of Research in Rural Electrification"—G. W. Kable, research director, National Rural Electric Project.

Afternoon Session—Thursday, October 16

Address of Welcome—M. H. Esser

"Extension Program in Rural Electrification"—C. E. Seitz, agricultural engineer, Virginia Polytechnic Institute.

"Garden Tractors"—A. A. Stone, agricultural engineer, Farmingdale, L. I., N. Y.

Sight seeing trip around Rochester.

Evening Session—Thursday, October 16

Symposium on Rural Electrification—Led by J. R. Haswell, Pennsylvania State College:

(a) "Electric Hay Hoists"—E. W. Pilgrim, General Electric Co.

(b) "Fractional Horsepower Motors in Agriculture"—R. G. Harvey, Syracuse Lighting Company.

(c) "Rural Line Extensions"—D. E. Blandy, New York Power & Light Corp.

(d) "Silo Filling"—H. C. Fuller, Utica Gas & Electric Company.

General Discussion

Symposium on Farm Machinery. Led by D. C. Heitshu, J. I. Case Company.

(a) "Low Cutting Corn Harvesters"—R. B. Gray, U. S. Department of Agriculture.

(b) "Farm Power Machinery in Pennsylvania"—R. U. Blasingame, Pennsylvania State College.

(c) "The Garden Tractor in New Jersey"—E. R. Gross, Rutgers University.

(d) "Combines in the East" — H. W. Riley, Cornell University.

General Discussion

Symposium on Farm Structures. Led by W. C. Harrington, Portland Cement Association.

(a) "Barn Ventilation"—L. G. Heimpel, MacDonald College.

(b) "Roofing"—M. A. R. Kelley, U. S. Department of Agriculture.

(c) "Potato Storage"—M. A. R. Kelley, U. S. Department of Agriculture.

(d) "Poultry House Ventilation"—F. L. Fairbanks, Cornell University.

General Discussion

Forenoon Session—Friday, October 17

"Farm Water Supply and Fire Protection"—H. L. Boyer, Goulds Pumps, Inc.

"Economic Phases of Farm Home Improvements"—E. Merritt.

"Controlling the Corn Borer"—R. B. Gray, U. S. Department of Agriculture.

"Potato Machinery"—G. E. Simmons, University of Maine.

Trip to Eastman Kodak Company plant.

Afternoon Session—Friday, October 17

"Electric Ventilation of Dairy Stables"—F. L. Fairbanks, Cornell University.

"Economics of Farm Machinery"—W. I. Myers.

Business Meeting.

Evening Session—Friday, October 17

Annual Banquet.

Forenoon Session—Saturday, October 18

"Electric Dairy Utensil Sterilizers"—A. V. Krewatch and H. E. Besley, University of Maryland.

"Milk Cooling"—Dr. A. C. Dahlberg.

"Heat Sterilization"—J. D. Brew.

Afternoon Session—Saturday, October 18

Football Game, University of Rochester vs. Wesleyan

Dedication of new athletic field.

Second "Dairy Engineers' Day" Planned

"DAIRY Engineers' Day," an innovation at the National Dairy Industries Exposition last October, will be a feature of the Exposition at Cleveland this year. The A.S.A.E. Committee on Dairy Machinery, sponsor of the event, has arranged with authorities of the Exposition to hold this second national gathering of dairy engineers in the Exposition Building, Thursday, October 23.

With the benefit and encouragement of last year's successful experience the committee has planned and practically completed arrangements for a strong program touching upon standardization, plant layout, research and instruction.

M. Van Antwerpen of the Gridley Dairy, Milwaukee, is the authority who will present the subject of "Standardization of Dairy Machinery."

There will be a symposium on "Dairy Plant Layout," contributed to by C. E. Clement of the Dairy Division, U.S.D.A., F. H. Kullman, Jr., Bowman Dairy Company of Chicago; and J. J. Mojonnier, Mojonnier Bros. Company. Mr. Clement will present the viewpoint of the scientist; Mr. Kullman, who has designed some of the best plants in America, the viewpoint of the designer and operator; and Mr. Mojonnier, that of the dairy machinery manufacturer.

"Collegiate Instruction in Dairy Machinery" is the title of a paper prepared by Prof. L. C. Thompson, University of Wisconsin, and J. H. Godfrey of the Creamery Package Company. It will interest, in addition to dairy engineers, the heads of college departments of agricultural engineering and of dairying.

Prof. Max Levine, of Iowa State College, and A. E. Kimberly, consulting engineer, Columbus, Ohio, will contribute to a symposium on "Disposal of Creamery Wastes."

Research papers scheduled include "Progress in Dairy Machinery," "Progress Through Engineering Research," "Factors Involved in the Design of Dairy Machinery," "Engineering Principles of the Continuous Manufacture of Casein," and "Heat Transfer in Dairy Equipment," all by well qualified and experienced research men.

H. F. Judkins of the General Ice Cream Corporation is to present a paper on the "Plant Equipment Supervision Program."

The opportunity to take in the Exposition and the "Dairy Engineers' Day" program in one trip is an inducement which will increase the attendance and interest at both events. Principals promoting this round-up of dairy engineers include J. H. Godfrey, H. S. Fielder, R. L. Perry, O. F. Hunziker, J. T. Bowen and A. W. Farrall. All are members and Mr. Farrall is chairman of the A.S.A.E. Committee on Dairy Machinery.

Pacific Coast Section Announces Meeting

IN A LETTER of September 1, Walter W. Weir, secretary of the Pacific Coast Section of A.S.A.E., called the attention of its members to the Section's plans for holding three meetings in the next few months.

First of these in order of occurrence is the regular autumn meeting of the Section, to be held at Fresno State College on October 8. The program includes the following features:

Efficiency of Air Cleaners for Internal Combustion Engines—A. H. Hoffman, agricultural engineer, University of California.

Windrowing Machinery—L. C. Badgley, president, Badgley Implement Company, Boise, Idaho.

The Agricultural Engineer from the Ranch Manager's Standpoint—Thos. G. Bard, engineer-manager, Berylwood Investment Company, Somis, California.

Luncheon—with Engineers' Club of Fresno (A.S.A.E. member as speaker).

Bulk Handling of Grain—E. N. Bates, in charge of Pacific Coast grain and rice investigations, U.S.D.A.

The Industrial Revolution and the Household—Greta Gray, associate professor of home economics, University of California.

Teaching Agricultural Engineering in the High School —W. L. Ruden, instructor, Salinas High School.

Cotton Planting—W. B. Camp, Fresno, California.

Plans for a meeting at Oakland in November, in connection with the Pacific Slope Dairy Show are under way and definite arrangements will be announced in the near future. This meeting will be made of particular interest to dairy engineers.

As previously announced, the Section will hold a joint, two-day meeting with the Land Reclamation Division of the A.S.A.E. in San Francisco, January 6 and 7, 1931. The committees in charge of the program and local arrangements have advance preparations well in hand and aim to leave with the visiting reclamation engineers the best possible impression of California hospitality.

Committee Personnel

(Continued from page 319)

Committee on Construction Practices for Animal Shelters
W. C. Harrington, chairman C. F. Miller M. A. R. Kelley G. C. D. Lenth S. A. Knisley C. P. Tobin

Committee on the Economics of Farm Buildings
J. L. Strahan, chairman J. C. Wooley Henry Giese A. W. Clyde G. I. Johnson

Committee on Grain Storage
R. H. Black, chairman W. M. Hurst H. M. Bainer J. D. Long M. A. R. Kelley H. R. Straight

Committee on Farm House Standards and Design
Deane G. Carter, chairman W. G. Ward W. A. Foster M. C. Betts R. C. Miller

Committee on Natural Building Materials
J. D. Long, chairman H. R. Straight

Committee on Fire Prevention and Protection
E. G. Lantz, chairman C. F. Miller H. E. Roethe T. F. Laist

TECHNICAL COMMITTEES—LAND RECLAMATION GROUP

Committee on Land Clearing
A. J. Bell, chairman A. J. McAdams N. A. Kessler W. J. Gilmore O. E. Hughes John Swenehart Geo. R. Boyd

Committee on Land Settlement
Frank Adams, chairman W. A. Rowlands M. R. Lewis George Sanford* David Weeks* J. W. Haw*

Committee on Land Drainage
Virgil Overholt, chairman George Amundson J. S. Glass J. A. King L. C. Le Bron R. W. Carpenter E. G. Welch W. L. Powers

Committee on Irrigation
M. R. Lewis, chairman F. E. Staebner R. B. West H. B. Roe G. E. P. Smith O. V. P. Stout A. L. Fellows H. C. Russell*

Committee on Run-Off from Agricultural Lands
S. L. Moyer, chairman C. E. Ramser, vice-chairman W. J. Schlick E. V. Willard R. A. Norton R. W. Baird R. R. Drake C. K. Shedd P. C. McGrew

Committee on Soil Erosion Control
M. R. Bentley, chairman C. K. Shedd H. L. Atkins, Jr. W. H. McPheeters M. L. Nichols F. O. Bartel J. S. Glass R. A. Norton P. C. McGrew L. A. Jones W. W. Weir A. K. Short C. E. Ramser

STANDING COMMITTEES—COLLEGE DIVISION

Committee on Agricultural Engineering Extension
Virgil Overholt, chairman I. D. Wood J. T. McAlister J. R. Haswell J. P. Fairbank W. G. Ward C. E. Seitz R. C. Miller George Amundson E. G. Welch

Committee on Cooperative Relations
R. U. Blasingame, chairman S. H. McCrory J. B. Davidson H. B. Walker G. W. McCuen Henry Giese

Committee on Teaching Methods
E. R. Jones, chairman Q. C. Ayres D. G. Carter J. B. Davidson C. O. Reed

Committee on Farm Mechanics in Secondary Schools
G. M. Foulkrod, chairman M. A. Sharp E. E. Brackett A. Carnes H. E. Murdock M. F. Thurmond J. G. Dent W. L. Ruden

Committee to Cooperate with Agricultural Teacher Trainers and State Supervisors of North Central Region
M. A. Sharp, chairman J. G. Dent H. E. Murdock

Committee on National Smith-Hughes Farm Shop Contest
Dan Scoates, chairman M. F. Thurmond

Committee on Student Branches
J. G. Dent, chairman R. H. Driftmier R. A. Palmer C. E. Seitz

Personals of A.S.A.E. Members

H. T. Barr, agricultural engineer, Louisiana State University, is joint author with R. H. Lush of Louisiana Circular No. 2, entitled "Silage and Silo Construction."

M. A. R. Kelley, associate agricultural engineer, division of agricultural engineering, Bureau of Public Roads, U.S.D.A., is author of U.S.D.A. Technical Bulletin No. 187, entitled "Ventilation of Farm Barns."

R. C. Miller joined the agricultural engineering staff of Ohio State University on October 1. For several years he has been in charge of agricultural engineering work at the North Dakota Agricultural College.

H. E. Murdock, agricultural engineer, University of Montana, is author of Montana Agricultural Experiment Station Bulletin No. 229, entitled "Tractor Hitches."

R. R. Parks, instructor in agricultural engineering, University of Missouri, presented a paper August 12, entitled "The Use of Electricity for Hotbeds," before the annual convention of the American Vegetable Growers Association in Milwaukee. He is also author of a recent mimeograph bulletin on the use of 5-horsepower electric motors for cutting ensilage.

R. H. Reed has completed his course at the University of Wisconsin and has accepted a position as instructor in the farm mechanics department, University of Illinois, Urbana. His new address is Farm Mechanics Building, University of Illinois, Urbana, Illinois.

John B. Woods, formerly fellowship student, New Jersey Experiment Station, is now assistant to Deane G. Carter, head of the department of agricultural engineering at the University of Arkansas, Fayetteville.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the August issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

William H. Carter, junior agricultural engineer, Bureau of Public Roads, U. S. Department of Agriculture, Washington, D. C.

Kenneth R. Frost, assistant agricultural engineer, University of California, Davis, Calif.

H. J. Gallagher, assistant professor of agricultural engineering, Michigan State College, East Lansing, Mich.

Olin M. Geer, experimental engineer, J. I. Case Company, Racine, Wis.

Warner M. Held, engineer, New Departure Mfg. Co., Chicago, Ill.

Boyce W. Knight, vice-president, Ensign Carburetor Co., Chicago, Ill.

Morris H. Lloyd, rural service director, Buffalo, Niagara & Eastern Power Corp., Buffalo, N. Y.

Carl Oberlin, vice-president, Martin Steel Products Co., Mansfield, Ohio.

Vladimir A. fon Reimers, military engineer, Bethlehem Shipbuilding Corp., San Francisco, Calif.

Transfer of Grade

Sydner H. Byrne, instructor, Virginia Polytechnic Institute, Blacksburg, Va. (Student to Junior Member.)

Floyd P. Trent, instructor, Virginia Polytechnic Institute, Blacksburg, Va. (Student to Junior Member.)

New A.S.A.E. Members

John T. Bowen, senior electrical engineer, U. S. Department of Agriculture, East Falls Church, Va.

Merwin T. Farley, special representative, Caterpillar Tractor Company, Stockton, Calif.

Lyman H. Hammond, rural electrification specialist, Westinghouse Elec. & Mfg. Company, Buffalo, N. Y.

Lawrence M. Null, power farmer, Macomb, Ill.

Gordon C. Olson, managing editor, "Motive Power," Gillette Publishing Co., Chicago, Ill.

Transfer of Grade

Otto Schnellbach, engineer, Reichskuratorium fur Technik in der Landwirtschaft, Berlin, Germany. (Affiliate Member to Member.)

Solon C. Thayer, farmer, Akron, Ohio.

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available' section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Men Available

AGRICULTURAL ENGINEER, with master's degree from a middle western college, 1930, desires position. Experience in large scale grain farming and rural electrification research in refrigeration. Can handle farm machinery and household equipment. College or experiment station work preferred. Willing to go anywhere. Age 26, unmarried. MA-180.

REGISTERED AGRICULTURAL ENGINEER desires position in teaching, research or commercial designing. Ten years' experience as engineer for manufacturers of farm building and material equipment. Good record for fulfillment of executive responsibility. MA-181.

AGRICULTURAL ENGINEER with eight years teaching experience now employed at a good position desires a change of location, preferably in the South. Interested in teaching but will consider any work pertaining to agricultural engineering. Have had special experience in farm shop, farm machinery, county agent work and as a writer. Thoroughly familiar with all general and special agricultural problems common in the South. Age 34. Married. MA-182.

Postions Open

EXTENSION AGRICULTURAL ENGINEER wanted by one of the leading state colleges to handle work in farm machinery and equipment with special emphasis upon forms of farm power for reducing cost of production by best use of mechanical equipment, applying both to the farm and the farm home. Requirements include, first, fundamental training in agricultural engineering principles; second, farm experience with knowledge of farm operation, preferably a man with some experience or training in farm management, and third, the type of man with personality and ability to train county agents, meet groups of farmers, and successfully teach this important subject to rural groups. Position can pay a maximum of $3600.00 to start. PO-173.